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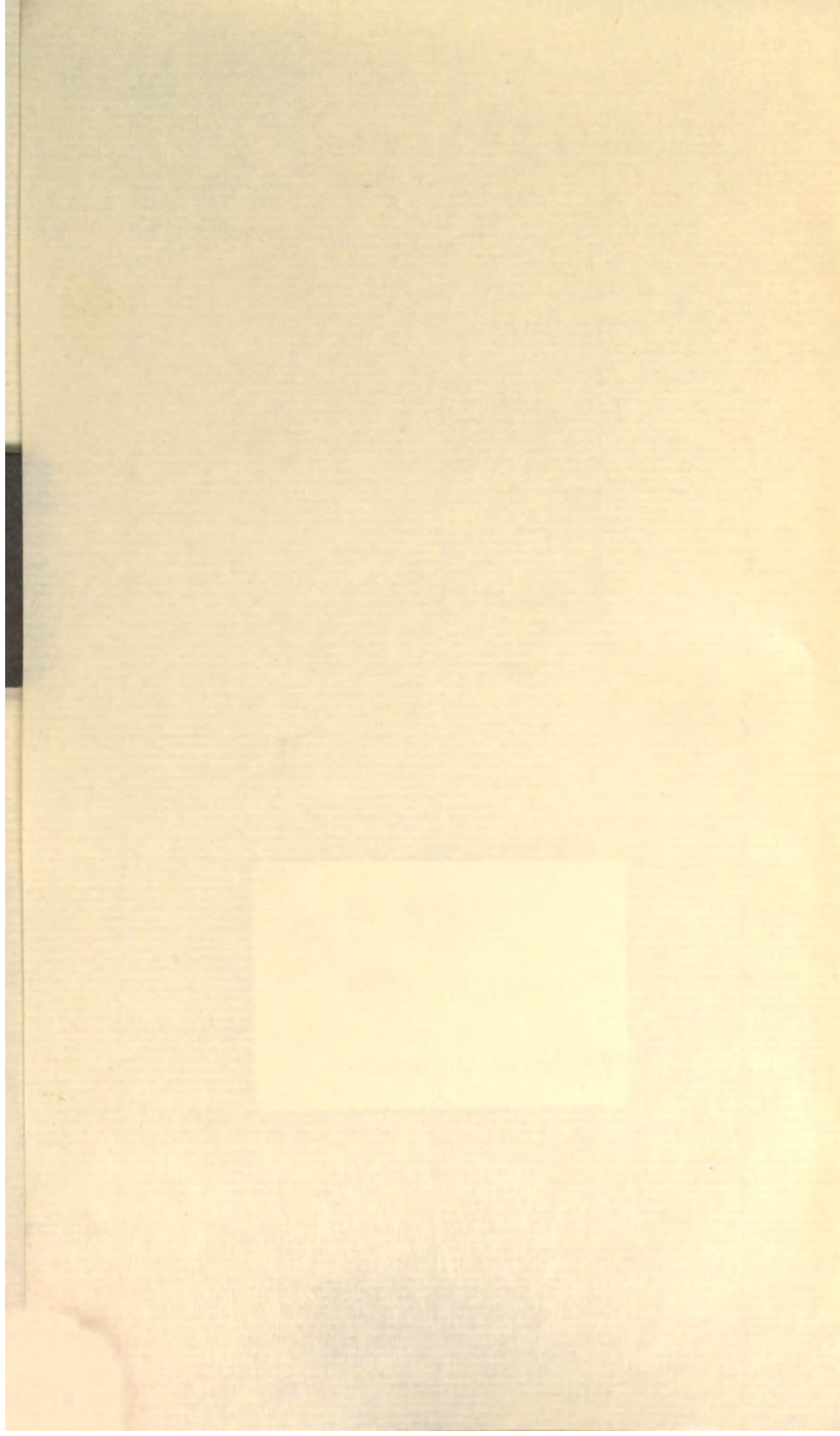
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Anat. 75th

AN

ESSAY

ON THE

STRUCTURE AND FORMATION

OF THE

TEETH IN MAN

AND

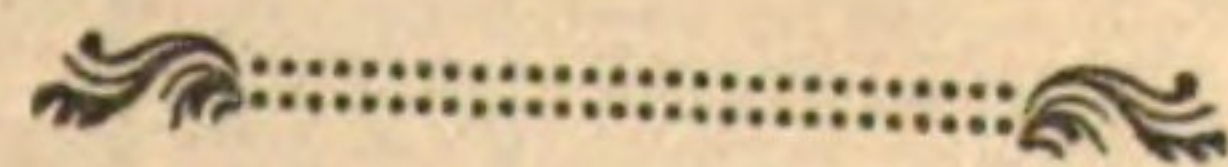
VARIOUS ANIMALS,

ILLUSTRATED WITH COPPER-PLATES.

BY

ROBERT BLAKE, M. D.

BEING PRINCIPALLY A TRANSLATION OF HIS
INAUGURAL DISSERTATION, PUBLISHED
AT EDINBURGH SEPTEMBER 1798.



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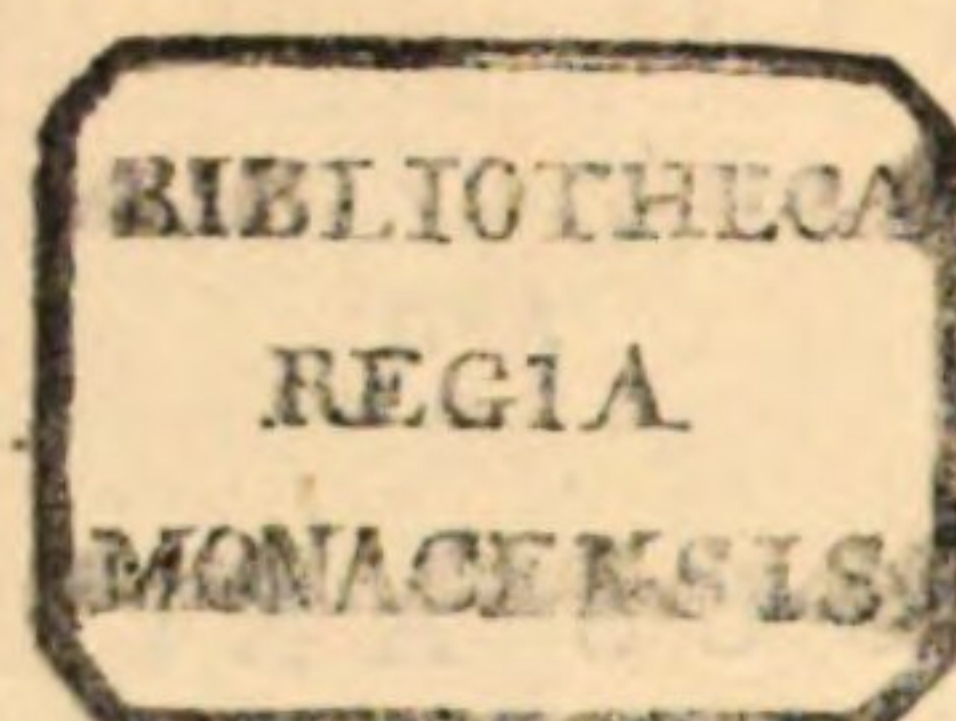
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1801.

Blake

*Teeth in man
and var. anim*

24 BS



TO
BRYAN HIGGINS, M. D.
WHOSE EFFORTS
IN THE
IMPROVEMENT OF NATURAL KNOWLEDGE
HAVE
"FOR THE ADVANTAGE OF MANKIND"
BEEN ASSIDUOUSLY AND SUCCESSFULLY EXERTED,
THIS ESSAY
IS GRATEFULLY AND AFFECTIONATELY
INSCRIBED BY
ROBERT BLAKE.

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E R R A T A.

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A few others of flight moment are left to the indulgence of the reader.

ADVERTISEMENT.

AGREEABLE to the laws of the university of Edinburgh, my thesis was presented to one of its professors in June 1798, three months previous to my graduation. Most of the anatomical preparations (drawings of which are annexed to the work) were made in Dublin in the year 1795, and the inferences deduced from them were communicated soon after to several gentlemen both in London and Edinburgh.

The favourable reception my thesis met with, from some of the highest literary characters, induced me, on my return to this country, to promise an immediate translation; but anxious to see some preparations in London, references to which I thought would more clearly elucidate some principles I wished fully to establish, and not having it in my power to visit that capital until September 1799, I thought better to defer its publication.

A

However,

However, the additions made, I trust, will in some measure apologise for its delay, and I hope it will now be found worthy the attention and indulgence of the public. In order to render this essay more generally understood, the quotations are translated as literally as possible, and although the original plan has been followed with little deviation, yet such alterations have been occasionally made as it appeared would be either useful or interesting.

INTRODUCTION.

INTRODUCTION.

TO man, as his exclusive privilege, has the investigation of her works been allotted by Nature. From this pursuit does he derive the truest source of mental happiness: With admiration he beholds, with rapture he traces her, through her mysterious paths, at once delighted and astonished at those admirable contrivances, by which she conducts her various operations. Nor has this spirit of inquiry been limited to any age or people; slow yet certain in its progress, it has with unerring pace pursued its grand design. Hence innumerable advantages have from time to time accrued to society: to this principle has the cultivation of philosophy in general been indebted; and thus has that division of it, more immediately connected with the preservation of our own species, been rescued from the hands of empirics, to be placed high amongst the other branches of science.

I need scarcely observe that this great progress in medicine, has been, as in other sciences, owing to an accurate and sedulous attention to its principles; I mean anatomy and chemistry, as well as the laws of the animal economy. Yet numerous and rapid as have been the different improvements and discoveries made in the various branches of these sciences since the year 1700, little has been done in that department, which I have selected for the subject of the following essay, since the year 1563, when Eustachius published the first edition of his *Opusculum de Dentibus*. From that period however, diseases of the teeth began to attract attention, and a few valuable works were written on that subject.

Amongst the first of these is a work published by *Urbain Hemard**, an ingenious French surgeon. Some others appeared nearly about the same time, as also in the course of the sixteenth

* *Recherche de la vraie Anatomie des dents, nature et proprietex d'icelles, avec les maladies qui leur adviennent.*
Published at Lyons, 1582.

century,

century, to notice which, the limits of this essay would scarcely allow me ; indeed I consider any reference to them at present unnecessary. About the year 1700, the necessity of some artificial mode of preserving the teeth attracted particular attention in Paris, and a few surgeons there, began to confine their operations to diseases of the mouth and teeth alone ; from which period may be dated the commencement of useful knowledge in that branch, founded on experience. Of those works published on the Continent the best is that by *Fauchard* *. Though a very ingenious and useful essay appeared afterwards on the same subject, by *Bourdet* †, this I had not an opportunity of perusing until some time after my thesis had been printed. The only treatise of consequence which has appeared in our language is by the celebrated Mr. John Hunter, under the title of the Natural History of the Human Teeth ‡. This contains some ingenious and

* *Le Chirurgien Dentiste*, published at Paris about the year 1740.

† *De l'art du Dentiste*, Paris 1757.

‡ Published at London 1771.

valuable observations ; but as many of them were collected from dentists of his acquaintance, and as Mr. Hunter did not confine his operations to that part of medical surgery in question, I should be less inclined to place implicit confidence in his opinions, respecting a branch, which, though limited, yet requires the most minute attention, and unremitting investigation.

On comparing these works with those of anatomists in general, I found innumerable points by no means cleared up, and by the advice of the celebrated Dr. Rutherford of Edinburgh ; I applied closely, some years to this branch of anatomy, with a view to ascertain the structure and formation of the teeth. During these researches, many circumstances occurred, which, as far as I have been able to learn, had been hitherto altogether overlooked ; and which seemed to me of the greatest importance in the management of the teeth and gums, particularly those of children. I therefore thought it more advisable, at once to submit my ideas on this subject, to the consideration

consideration of the public, even with all their imperfections, than delay them to a future period. It is my intention however to treat of the diseases incident to the teeth and gums, more fully hereafter.

To be more readily understood, I have annexed plates, representing those preparations which I thought most essential; some of them were not recent, owing to the very great difficulty of procuring subjects which had died, at the precise period when the gradations would have been particularly conspicuous; of course the engravings from these cannot be expected to convey as perfect ideas of them, as could have been wished. Some of the engravings are larger, others somewhat smaller than the preparations they represent; this necessarily happens where compasses cannot be used: for the most part, however, they are accurate.

As I intend in a great measure to confine my observations in the following essay, to the teeth and gums, I must refer those who wish
for

for a more particular description of the jaws, to works written on *Osteogeny* and *Osteology* *. It is however necessary to mention, that in general about two months after conception, ossification commences in the membranes and cartilages of the jaws. For example, the under jaw is at first composed of two pieces connected by ligaments at the middle of the chin. The base of each piece, is the part which begins to ossify; then the sides, which are in general called alveolar processes, undergo a progressive change of consistence. They are formed of two laminæ, an external one next the cheek, and an internal one next the tongue; so that a groove is formed by these processes, in which are contained the vessels, nerves, and several little soft pulpy substances, all of which are separated from each other by proper membranes. As ossification advances, bony fibres shoot across from contrary sides of the processes, forming an enclosure round each pulp, the circumference of which is commonly called a socket, and as

* Albinus, *ossium fœtus humani*; Munro, Nesbitt, Havre, &c.

some teeth have several roots, a distinct socket is formed round each root.

In children a certain number of teeth are formed, which being intended to last for only a limited time, they then gradually loosen, fall out, and are succeeded by as many new ones, some of them fall about the sixth or seventh year, while others remain until the tenth, twelfth, or even the fourteenth year. The necessity for shedding the infantile teeth will appear sufficiently obvious, when we consider that larger teeth in general are necessary for the purposes of an adult, than for those of a child; so that nature found it an easier process to form new ones, than extend or enlarge the old, which indeed from their particular structure could not be effected. When the parts have arrived at such degree of extent, as to allow teeth to be formed sufficiently large, the teeth so formed are never shed; such are the adult or Permanent grinders. It is to be understood however, that these observations relate to man, or quadrupeds, whose teeth resemble those of man; for in other animals a remarkable difference occurs

curs, as shall afterwards be particularly noticed.

The annual change of the shell of the lobster, and many other species of shell fish, may be explained on similar principles; for their shells are formed nearly in like manner with the teeth, and of course they cannot extend; so that when the body of the animal is about to increase, the shell opens in a particular place, allows the soft parts to get out, and in some short time after, a new shell is formed over them.

The first teeth according to the celebrated Albinus, I have called Deciduous; but will now make use of the word Temporary in preference, that being the term in most general use; these teeth are twenty in number, and are divided by Mr. Hunter into three classes, called, *Incisores*, *Cuspidati* and *Molares*, or Grinders. There are in each jaw, four *Incisores*, two *Cuspidati*, or those commonly called eye-teeth, and four *Grinders*.

The

The teeth which succeed them, and the entire of the adult set, I have called Immutable, though Albinus confines this term to the grinders of the adult, which, as I said before are not shed; the word Permanent, however, I intend to substitute for it. These teeth are thirty-two in number, and are properly divided by Mr. Hunter into four classes; in each jaw, there are four *Incisores*, two *Cuspidati*, four *Bicuspides*, or the two at each side immediately next the *Cuspidati*, and six *Grinders*.

As almost every name which has been hitherto made use of to express that hard and polished substance, with which the body of a tooth is covered externally, supposes it to be of a vitreous nature, than which nothing can be more erroneous; I have taken the liberty to call it the *Cortex Striatus*, as such an appellation seems to coincide more with the nature of it.

It is scarcely necessary to observe, that each tooth is divided into three portions; the body
or

or that part which appears above the gum ;
the neck or termination of the Cortex Stria-
tus on the bony part ; and the root.

CHAP.

AN
ESSAY,

Ec. Ec.

CHAPTER I.

Of the Rudiments of the Temporary teeth.

ON examining the jaws of a foetus, about the fourth month after conception, I observed the rudiments or vascular membranes of twelve teeth in each jaw; scil. those of all the temporary teeth, and also those of the anterior permanent grinders. These membranes or sacs were even at this period sufficiently apparent, and so intimately connected with the internal part of the gum, that they seemed derived from it, and came away with it, when
torn

torn from the groove in the jaw, leaving behind the vessels, nerves, &c. with which they had been in contact. At this period there was scarcely any appearance of the bony fibres, shooting across from the alveolar processes, to form sockets; except those intended for the Incisores.

The vessels which enter the lower part of these sacs, deposit in them a substance, exactly similar to jelly in consistence and transparency; upon this the bony part of the tooth is formed; it becomes very vascular, and assumes nearly the shape and size, which the upper part of the tooth is to have, after the ossification of it has commenced. This substance is commonly called the pulp; on some of them I observed elastic bony shells already formed in the foetus I have just mentioned*.

In the left side of the under jaw of a foetus, about the fifth month, (the internal part of the alveolar process being cut away), the con-

* Tab. i. Fig. 1.

nexion of the vessels with the sacs appeared as they are represented in Tab. i. Fig. 2. The preparation from which this figure was taken, had been dried and afterwards preserved in spirits of turpentine, so that the membranes, &c. appear very much contracted. But in Tab. v. Fig. 1. the right side of the recent under jaw of a foetus calf, with the connexion of the gum, vessels, &c. are accurately represented.

In a foetus between the eighth and ninth month, ossification had commenced on all the pulps, and at one point, even on the pulp of each of the anterior permanent grinders*. The rudiments were all of them nearly separated by bony partitions, except those of the posterior temporary and anterior permanent grinders, which were still contained in the same socket †.

In children at birth, I have generally found the shells somewhat more advanced, and all

* Tab. i. Fig. 3. 1.

† Tab. iii. Fig. 2. d. d.

the points of ossification nearly united on the pulps of the temporary grinders.

The sacs or membranes which surround the shells, are thickest and most dense next the gum; but become by degrees softer and more gelatinous towards the lower part. They can be easily separated into two lamellæ, the external of which is spongy and full of vessels. The internal one is more tender and delicate, and seems to contain no vessels capable of conveying red blood, at least I could not discover any such, even though assisted by a very subtil injection. These experiments I have repeatedly made, on the membranes of premature calves, with the same success *. The celebrated Mr. John Hunter however asserts the very reverse, for he says †, "The external is soft" and spongy, without any vessels; the other "is much firmer, and extremely vascular." The internal part of these sacs, soon after the commencement of the bony shells, deposits on their points and sides a soft earthy matter,

* Tab. v. Fig. 6. b. b. † Nat. Hist. of the Human Teeth, p. 87.

moistened

moistened with a mucilaginous fluid ; a small quantity of which is found between the membranes and shells. This earthy matter I found even at birth so soft, that it could be scraped off with the nail of the finger. It may be proper to remark, that it is this soft earthy matter, which afterwards becomes the *cortex striatus*, as will be fully demonstrated in its proper place.

CHAPTER II.

Of the pulp, and formation of the bony part of a tooth.

THE pulp seems intended for a purpose similar to that of the cartilaginous matter of the other bones, though the process of its ossification is conducted in a different manner. A tooth is formed from without inwards, the part first formed being the outermost layer, which is as large, and probably as perfect at first,

first, as at any subsequent period of life. I allude here to that part only of the outermost layer, on which the fibres of the cortex striatus are afterwards to be arranged.

Offification commences on the highest or most prominent point of what is afterwards to be the cutting edge or grinding surface of the tooth; as also, on as many points, as there are eminences on the pulp. The bony matter being first deposited on these points, it necessarily becomes hollowed towards the pulp, and gradually augmenting, at length forms over it small elastic shells.

Of On the *incisores* and *cuspidati*, whose formation is more simple than that of the others, there is in general only one shell formed *, but on the grinders several of them appear. On the anterior or small grinders, there are four shells formed, sometimes however but two †. On the posterior or large grinders there are in general five shells, of which, in

* Tab. i. Fig. 1. g. g. h.

† Tab. i. Fig. 1. i.

the

the under jaw, three are placed externally or next the cheek, and two internally *. In the upper jaw, they are so situated, that their eminences are adapted to the hollows of the opposite teeth in the under jaw. †. As ossification advances, the bases of these shells come in contact, and at length unite, so as to form one shell ‡, after which, ossification proceeds for some time, as in the Incisores and Cuspidati, gradually extending over the greater part of the pulp; and when so far advanced as to form the body of the tooth, it begins to contract from without, thus shaping the neck, from which the root or roots are to commence §.

As the bone of the tooth increases in thickness, the pulp is proportionally diminished, and seems as it were converted into bone; its connexion however with the bony part is very slight, except at its extreme elastic edge, so that when the membrane surrounding the tooth is

* Tab. iv. Fig. 1.

‡ Tab. iv. Fig. 2. and 9.

† Tab. iv. Fig. 8.

§ Tab. iv. Fig. 3, b.

cut open, the shell can be taken from off the pulp, without any apparent violence; indeed, without altering the shape of the pulp, or scarcely its connexion with the vessels. When the shell is removed, the pulp appears covered with a very delicate membrane, on which the vessels form a net-work. This seemsto be a propagation of the *periosteum* which enters the canal of the jaw, along with the vessels, and probably from whence are derived the bony lamellæ of which a tooth consists *. Though this membrane is so slightly connected with the internal part of the shell, I cannot think Mr. Hunter's assertion warrantable, when he says, "nor are there any vessels going from the one to the other †." He might as well have denied the existence of vessels in the crystalline lens, as it more readily slips out of its capsula, than this pulp from its shell.

As the pulp has originally no process answering to the root or roots, it has been supposed that it is lengthened, or squeezed out so

* Tab. i. Fig. 8. a. b. † Nat. Hist. p. 89.

as to form them, according as the cavity in the body of the tooth is filled up by the ossification *. I have already mentioned that the pulp at first assumes little more than the size of the upper part of the body of the tooth, which is to be afterwards formed upon it; but it is deposited and extends in proportion, as ossification advances. It is the pulp and its vessels which give a determinate shape and size to the body of the tooth, and it will in its proper place be shewn, that its processes determine the shape and size of the roots. How is it possible that the simply filling up the cavity in the shell of a grinder, could occasion the pulp to lengthen out into two, three, and sometimes four roots?

Of those teeth which are to have but one root, the pulp increases in length as I have described, becoming more and more contracted towards the point; and as ossification advances, the bone forms on it a kind of conical tube †.

* Nat. Hist. p. 90.

† Tab. iv. Fig. 23, 24, and 25. a. a. a.

But

But, in those teeth which are to have more than one root, a beautiful process is carried on. In the grinders of the lower jaw, which in general have but two roots, the pulp is divided into so many processes, a little below the neck; at this period, there is but one general opening in the shell, from the opposite sides of the edge of which, osseous fibres or little bars shoot across, through the division of the pulp; these meet and unite in the middle, and so divide the cavity of the shell into two openings, forming over it a little arch*. In the grinders of the upper jaw, which have in general three roots, the pulp is divided into as many processes, and the osseous bars shoot through them, from as many different points in the margin of the shell, and uniting in the middle divide the cavity into three openings, two of which are placed externally, and one internally†. Sometimes an osseous point is deposited in the centre of these processes, and fibres shooting across from the margin of the

* Tab. iv. Fig. 3, and 4. a. a.

† Tab. iv. Fig. 10, and 11. a. a.

shell join it, which answers the same purpose *. From these openings, the processes of the pulp commonly become more and more divergent, and ossification extending on them forms a conical or flattened tube on each, as in teeth which have but single roots †. Sometimes the pulp is divided at the neck only into two processes; ossification goes on for some time as usual, but one or both of these become divided again, and so three or four roots are formed. I have met a few of the permanent grinders, in which the pulp did not divide into processes, so that only one root was formed‡. The pulp continues to advance faster than the ossification §, until each process has acquired its proper length and shape; then the pulp except where the vessels and nerves enter, becomes entirely surrounded with bone.

Mr. Hunter mentions ||, “ By the observations which I have made in unravelling the texture of the teeth, when softened by

* Albin. Acad. Annot. Lib. ii. p. 17.

† Tab. iv. Fig. 22. a. § Ibid. Fig. 5, and 12. a. a. a.

‡ Tab. iv. Fig. 31. a. || Nat. Hist. p. 92.

“ an acid, and from observing the disposition
 “ of the red parts in the tooth of growing
 “ animals, interruptedly fed with madder, I
 “ find that the bony part of a tooth is formed
 “ of *lamellæ*, placed one within another.
 “ The outer *lamella* is the first formed, and is
 “ the shortest: the more internal *lamellæ*
 “ lengthen gradually towards the fang, by
 “ which means in proportion as the tooth grows
 “ longer, its cavity grows smaller, and its sides
 “ grow thicker.” Now from my observations,
 the fact is directly the reverse; the outer *lamella*,
 which is the first formed is longest, the inter-
 nal *lamellæ* become shorter and shorter, and
 the last formed is the shortest*. Hence in
 teeth with single roots, the cavity of the shell
 is not only diminished, but it recedes from the
 apex or cutting edge of the tooth, whilst a
 conical tube is left for the admission of vessels,
 &c. the base of which ending in the body of
 the tooth, has its opening or point nearly in
 the extremity of the root †. The *lamellæ* of

* Tab. iv. Fig. 20, 21, 22, 23, 24 and 25. b. b. b.

† Ibid. Fig. 25. a.

a grinder

a grinder, are distributed more irregularly than those of any other tooth, on account of the protuberances of its pulp. As its external *lamella* advances very slowly, a great number of the internal ones are advancing, at the time that the external *lamella* has got so far as to form the neck. So that the cavity of a grinder recedes from the grinding surface, more rapidly than that of any other tooth *. After the roots commence, the cavity is soon diminished, the ossification going on at the same time at both the upper and under parts of it †. As many conical or flattened tubes are left leading to the cavity, as there are roots; and as many hollows or depressions in the superior part of the cavity, as there are protuberances on the grinding surface. The pulp, though very much diminished, still retains nearly its original shape ‡.

It may appear singular, that the pulp should not be entirely obliterated, and the ossification

* Tab. iv. Fig. 20. b. † Ibid. Fig. 21, and 22. a. a.

‡ Ibid. Fig. 21, and 22. d. d.

completed, without any remaining cavity ; it however affords this advantage, that the vessels and nerves distributed on the soft membrane of the pulp may have free action and not be compressed ; by which means the internal bony part of the tooth may be more readily nourished.

It is asserted by a celebrated Anatomist, that he has constantly found two holes near the point of each root, for the admission of vessels, not only of the Incisores and Cuspidati, but also of those of the Grinders ; which he supposes to have been established by nature, in order to guard against accident, lest if one vessel were injured or destroyed, the other might continue to nourish the pulp. I confess I was never so fortunate as to meet a single instance of this kind, even in the Incisores of large animals ; except in such cases as Eustachius mentions, where he says, (speaking of the roots of the permanent grinders), “ Many of those
 “ (sc. roots,) being flattened, their sides thus
 “ approach ; so that, instead of a circular
 “ opening, an oblong one is formed, the cen-
 “ tral

“tral points of whose sides coming into con-
 “tact, leave at either end a small canal * †.”
 In such roots, however, I have frequently
 found but one opening externally, for the ad-
 mission of vessels &c. but after their entrance,
 each divided into two branches. HAVER
 mentions ‡, that in a tooth which had but one
 root, he met two passages, one at each side.
 This root must have been formed in the man-
 ner Eustachius describes. I have seen a few
 of the permanent Incisores with almost two
 distinct roots, the Cuspidati with two, some-
 times with three roots, and the Grinders with
 four and even five roots, and of course as many
 openings as roots.

* Tab. iv. Fig. 7. a.

“† Sæpe enim earum multæ hanc ob causam am-
 “plam rotunditatem in latitudinem mutant, cujus duæ
 “extremæ partes quum se mutuo occurfu tangant,
 “foramen angustum et oblongum efficitur, quod in me-
 “dio fere obcæcatum duos parvos canaliculos utrimque
 “obtinet:” (*Opuscul. De Dentib. p. 26.*)

‡ Osteologia, p. 79.

CHAP.

CHAPTER III.

Of the gradual waste of the membrane which surrounds the body of a tooth, and the period at which the temporary teeth in general appear.

THE membrane which deposits the earthy matter of the *Cortex Striatus*, does not adhere to, but loosely surrounds the body of the tooth ; but as soon as the neck is formed, the margin of the membrane adheres to it so firmly at that part, that it cannot be separated from it, without lacerating several vessels, which pass from it to the bone. The membrane becomes much thinner at this part, and I could not separate it at any period into two lamellæ*.

As ossification advances on the root or roots, the body of the tooth rises in the socket, and

* Tab. iv. Fig. 12, b.

of course the investing membrane rises with it.

The *Cortex Striatus* is first perfected or crystallized on the cutting edges or protuberances of the tooth, and proceeds gradually from thence to the neck where it terminates; and in proportion as the first part of the *Cortex Striatus* is crystallized, that portion of the membrane which formed it becomes thinner, less vascular, and at length, having performed the particular function for which it was destined, is totally wasted or absorbed. The gum also partakes of this tendency to waste, and the tooth gradually appears through it; part of the membrane still remains on the body of the tooth *, this however is wasted, as the *Cortex Striatus* covered by it attains to perfection. So that all that portion of the membrane, which loosely surrounded the body of the tooth, is destroyed when the tooth has risen to its proper height.

* Tab. iv. Fig. 5, b.

De la Sonne *, and other physiologists, attempt to assign a cause, why the teeth rise and pass through the gum, by saying; that as roots are added, the bodies of the teeth are pushed or forced up through the gum, this being softer than the bottom of the sockets. But when we come to consider the appearance of the permanent teeth, we shall be fully sensible how inadequate such a theory is.

It has been mentioned by most authors, who have written on dentition, that the membrane which surrounds the body of a tooth, is stretched, bruised, and even lacerated by the increased size of the tooth; Dr. Underwood supposes it to be strong and nervous, and adds †, “ The most painful part of dentition, “ and that in which children are most exposed “ to convulsions, is usually from the teeth “ cutting through the *periosteum*, (or nervous “ membrane mentioned above), that covers

* Acad. des Scien. in 4to. L'an. 1752. Mem. p. 168.

† Diseases of Children, vol. i. p. 213, and 214.

“ the teeth.” Van Swieten although he did not believe the temporary teeth had roots, says, “ These rudiments of the teeth are “ placed in the sockets of the jaws ; but the “ opening from each of these sockets, is cover- “ ed by a thick coriaceous membrane, which “ must be bruised or even torn by the tooth “ in bursting out ; so that after the tooth had “ burst out, the ragged edges of this membrane “ have been observed by the accurate *Herrif-* “ *sant*. These edges becoming dry, fall away “ spontaneously. Therefore the tooth in en- “ deavouring to make its way out, must exert “ a considerable force, in order to break “ through this membrane *.”

“ * Hærent illa dentium germina in alveolis maxilla- rum ; sed horum alveolorum exitus tegitur mem- brana satis densa coriacea, quæ ab erupturo dente pertundi debet, quinimo lacerari ; ita ut, post erup- tionem dentis, laceræ hujus membranæ lacinia ob- servatæ fuerint ab accurato in similibus indagan- dis *Herrissant*. Exsiccatæ dein hæ lacinia sponte cadunt. Magna ergo satis vis a dente erupturo fieri debet, ut hanc membranam rumpat.”

Comment. vol. xiv. p. 743.

It

It appears rather strange that Van Swieten could imagine, that the temporary teeth, which in another part of his work, he observes, have no roots, could perform all these violent efforts, so as to burst through this membrane. Even Mr. Hunter says*, “When the tooth cuts the gum, this membrane or capsula is likewise perforated; *after which* it begins to waste.” Others are of opinion, that the membrane being lacerated, the body of the tooth passes up through it, and that it afterwards becomes the periosteum of the root. From what I have already said, the impossibility of a tooth bursting or rising through its membrane will be easily perceived, for as it is firmly united to the neck of the tooth, it must partake of the same precise motion with the tooth, and therefore must after such motion of the tooth retain the same relative position towards it, as before. So that the disappearance of the membrane is not owing to a rupture of it, but to a wasting or absorption of it, in proportion as it has perfected the *Cortex Striatus*. This fact will be more fully explained, when

* Nat. Hist. p. 87.

we come to speak of the teeth of animals in general. I have seen the ragged edges of the membrane, appearing above the level of the gum; a similar appearance was no doubt observed by Herissant, though he attributed it to a wrong cause.

Galen, Eustachius, and others were of opinion, that the upper teeth appeared sooner than the under; they were fully aware however, that they appear irregularly and at different periods. Mr. Hunter describes their appearance in the following words *. “ The
 “ *incisores* begin to cut or pass through the
 “ gums; first, generally in the lower-jaw; but
 “ the *cuspidatus* and *molares* of the foetus, are
 “ not formed so fast as the *incisores*; they ge-
 “ nerally all appear nearly about the same time,
 “ viz. about the twentieth or twenty-fourth
 “ month; however, the first grinder is often
 “ more advanced within the socket than the *cus-*
 “ *pidatus*, and most commonly appears before
 “ it.” Chirurgical writers in general, give us a

* Nat. Hist. p. 78.

most curious jumble, respecting the appearance during dentition; and most of the strenuous advocates for cutting and hacking the gums of children, seem perfectly ignorant of the order in which the teeth appear. Dr. Underwood says *, “ The two front teeth in the
 “ lower jaw are usually cut the first, and it is
 “ commonly a few weeks longer, before the
 “ corresponding ones in the upper jaw make
 “ their appearance. After which, it is fre-
 “ quently a considerable time before the next
 “ under teeth come out; but sometimes, though
 “ not often, six or eight are cut in a hasty
 “ succession. Children sometimes cut their
 “ teeth irregularly, or crows, as it is called, both
 “ by the teeth appearing first in the upper
 “ jaw, and also at a distance, instead of being
 “ contiguous to each other: this is accounted,
 “ and with some reason, an indication of pain-
 “ ful or difficult dentition.” It is unnecessary at present, to enter more fully into the inaccuracies of these authors, or to say any thing respecting their operations, (which were all

* Diseases of Children, vol. i. p. 205.

blindly,

blindly, and I must say, very often rashly performed for want of anatomical knowledge of these parts,) as I intend to enlarge considerably on this subject, when I come to treat on dentition.

As ossification does not commence on all the pulps at the same time, in general those on which it first commenced are soonest perfect, and of course they appear through the gum first. I have observed on examining the teeth of a number of children at birth, that the bodies of the middle *incisores* of both jaws were most perfect; the lateral *incisores* and the small grinders next; and the *cuspidati* and large grinders least perfect*. In general the teeth begin to appear about the sixth, seventh or eighth month after birth; but there are some exceptions to this rule; owing to the rapid progress of ossification in some children, and the slowness of it in others. There are a few instances of children at birth having one or

* Tab. i. Fig. 3. h. h. i. k. k.

two of the *incisores* already cut, and in such cases it is often necessary to remove them immediately; on the contrary, in children apparently healthy, they have not begun to appear till the first, second, or even the third year. They for the most part appear in pairs, or the two corresponding with each other, nearly at the same time. The first are the middle *incisores* of the under jaw, in a few weeks after the middle *incisores* of the upper; in a month or six weeks after, we have reason to expect the lateral *incisores* of the under jaw, and in a short time after those of the upper; about the twelfth or fourteenth month, the anterior or small *grinders* of the under jaw appear, and frequently about the same time those of the upper; about the sixteenth or twentieth month the *cuspidati* appear first in the lower jaw, and from the twentieth to the thirtieth month the posterior or large *grinders* appear in the same order: so that in general about the second or third year, the twenty temporary teeth are complete.

We

We must not expect however to find the teeth always appear in the precise order I have just now mentioned. I have frequently met with some irregularities, such as one tooth appearing a considerable time before its fellow ; all the *incisores* of the under jaw, appearing before any of the upper ; and the reverse, though very seldom, has sometimes taken place ; the anterior *grinders* sometimes appear sooner than the lateral *incisores*, and the lateral *incisores* of the upper jaw, sooner than those of the under ; I have sometimes observed the posterior *grinders* appear earlier than the *cuspidati* ; but I never saw an instance of the *cuspidati* appearing previous to the small *grinders* ; sometimes three or four teeth appear nearly at the same period, but I never met an instance of the *cuspidati* and *grinders* appearing in such rapid succession as Mr. Hunter and Dr. Underwood mention. Dr. Armstrong says *, that he met two cases, where the small *grinders* appeared first of all ; I have lately met a case similar ; however by carefully examining

* Diseases of Children, p. 82.

the gums of a child, we can seldom mistake what tooth is about to appear, as the gum is frequently somewhat higher over it, than elsewhere *, or it becomes so thin, that through it the shape of the tooth can be perceived.

CHAPTER IV.

Of the commencement and formation of the permanent teeth.

HAVING now fully traced the temporary teeth, from their origin to their perfect state; that I may be better understood, I shall follow nearly a similar plan, with respect to the permanent. I think it unnecessary to dwell on the ingenious hypotheses of Vesalius, Diemerbroek and others, who supposed that the bodies of the permanent teeth were produced

* Tab. 1. Fig. 4, and 5. a. a.

from

from the old roots of the temporary. Diemerbroeck adduces in support of his doctrine an instance of the stag, who changes his horns every year, or year and half, when as he supposed from their old roots, new horns arose; but a full account and refutation of these opinions may be seen in the works of the learned Albinus*. Fallopius supposed, that a certain latent feed in the jaws produced a new range of teeth†. But Eustachius explained much more clearly what takes place, than any of his predecessors, and indeed comes very near the truth, in the following words. “ On
 “ dissecting a child immediately after birth,
 “ both jaws being laid open, the *incisores*, *ca-*
 “ *nini* and three grinders appeared, partly gela-
 “ tinous, partly bony, of no small size, and
 “ completely surrounded by their sockets; but
 “ having carefully removed the *incisores* and
 “ *canini*, I observed a very thin interstice,
 “ scarcely converted into bone, which being
 “ removed with equal care, I discovered the
 “ like number of *incisores* and *canini*, almost

* Acad. Annot. lib. II. p. 3.

† Observat. Anatom.

“ gelatinous

“ gelatinous and of a smaller size, which ly-
 “ ing behind the former ones, and in their
 “ proper cavities, were placed directly opposite
 “ to one another. I confess, I did not see
 “ any trace of the grinders and jaw teeth
 “ which appear about the seventh year, and
 “ often much later *.

Urbain Hemard, an ingenious French ana-
 tomist, makes use of nearly the same words,
 when treating on this subject. “ He had dis-
 “ sected, in presence of his friends, capa-
 “ ble of understanding this demonstration, se-
 “ veral infants three or four days old, and

“ * Fœtu, simul atque editus est, dissecto, aperta utra-
 “ que maxilla, occurrunt *incisores*, *canini*, ac tres *mo-*
 “ *lares*, partim mucosi, partim ossei, non obscuræ magnitu-
 “ dinis, suisque præsepiolis undique vallati; *incisoribus*
 “ autem et *caninis* docta manu detractis, tenuissimum in-
 “ terstitium vix osseum factum conspicitur, quo pari dili-
 “ gentia amoto, obviam veniunt totidem *incisores* et *ca-*
 “ *nini* pene mucosi et longe minores, qui post alios
 “ priores in propriis caveis latentes, singuli singulis e re-
 “ gione oppositi collocati essent; *molarium* et *genuino-*
 “ *rum* qui circa septennium, ac longe etiam postea ori-
 “ untur, fateor me nullum vestigium vidisse.” *Opuscul.*
de Dentib. p. 46.

“ others

“ others just born ; he found that the *incisores*,
 “ the *canini* and some *molars* on each side of
 “ the jaws, were in part bony and in part mu-
 “ cilaginous, of middling size, and surrounded
 “ by their little cases or sockets ; that after
 “ having removed the first *incisores* and *canine*
 “ teeth, he observed a bony partition ; and
 “ that after having likewise removed this, he
 “ met under it, as many new *incisores* and *canine*
 “ teeth, as there were of the first, almost en-
 “ tirely mucilaginous. But as to the great
 “ *molars*, which at seven or eight years old,
 “ or a long time after, begin to appear through
 “ the gum, he confesses, he never found any
 “ trace or beginning of them *.”

It

“ * Il avoit anatomisé, en présence de ses amis capa-
 “ bles de cette démonstration, plusieurs enfans nez de-
 “ puis trois ou quatre jours, et d'autres à l'instant de leur
 “ naissance, il á trouvé que les incisives, les canines, et
 “ plusieurs molaires de chaque côté des machoires, étoi-
 “ ent en partie osseuses, et en partie mucilagineuses, de
 “ médiocre grandeur, et entourées de leurs petits étuis,
 “ ou alvéoles ; qu 'après avoir tiré dehors les premières
 “ dents incisives et canines, il avoit remarqué un entre
 “ deux osseux ; et qu 'après l'avoir pareillement ôté, il
 “ avoit

It appears that Urbain Hemard was not acquainted with Eustachius's work, so that he is entitled to an equal share of merit; and although the celebrated Albinus confirms the description of these parts, as related by Eustachius, yet Dr. Nesbitt thought them imaginary, and says *, " There is not at birth, as Eustachius imagined, the least appearance that I could ever find of the layer or row of teeth, by which the first is afterwards usually thrust out." Since so great an anatomist as Dr. Nesbitt did not credit the demonstrations of Eustachius, though supported as I already mentioned by Albinus, because similar appearances did not occur to him, and finding such an imperfect description of their origin in Mr. Hunter's work, I have dissected a great

" avoit rencontré dessous tout autant de nouvelles dents
 " incisives et canines qu'il y en avoit auparavant, pres-
 " que toutes mucilagineuses. Quant aux grosses mo-
 " laires, qui à sept ou huit ans, ou longtems après, com-
 " mencent à sortir, il confesse n'en avoir jamais trouvé
 " aucune trace, ni commencement." *Fauchard Chirurgien Dentiste*, p. 37. *et seq.*

* Hum. Osteogeny, p. 98.

number of infants to ascertain this point, which I think of the greatest importance.

I have already mentioned, that in the youngest foetus I examined, I observed the rudiments of the four anterior permanent grinders*, though I could not discover the slightest appearance of any of the other permanent teeth. But in a foetus about the eighth month, I found the commencement of the fangs of the *incisores* and *cuspidati*; they were not placed under the temporary teeth, nor indeed so deep in the jaw, but within side of them, that is to say, in contact with their inner surface, lying between that and the internal plate of the alveolar process, and as Albinus remarks, they were contained in the same sockets with the temporary †. In a foetus between the eighth and ninth month, these fangs were all perfectly distinct, and the pulps of the middle incisores were tolerably advanced, they were elongated a little in the sockets, and the jaws happened to be so far advanced, that the upper surface of

* Vide Chap. 1. Page 1.

† Ossium Foetus Humani.
the

the sockets of the middle permanent *incisores* were ossified, the lower part remaining still membranous: the other sockets were less perfect, and exactly in that state as described by the accurate Eustachius. In children somewhat farther advanced, I found them nearly as Hemard mentions, and I confess I did not observe in such young subjects the slightest vestige of those which succeed the temporary *grinders*, or any appearance of the middle permanent ones.

Having fully shewn that the assertions of Eustachius, Hemard and Albinus are true, I come now to treat more at large, of the relative situation and connexion of the rudiments of the permanent with the temporary teeth, which have been hitherto unaccountably overlooked. By the writings of those great men we are informed, that a certain number of the permanent teeth began to be formed previous to birth, but we are still perfectly ignorant respecting the manner of their formation or connexion; and have had nothing to guide us but imaginary conjectures, respecting the teeth
which

which appear at a more advanced period of life. I think it unnecessary to say any thing on the hypothetical suppositions of Hippocrates, Fallopius, Eustachius, &c. but will dwell on the facts which I have discovered, and which I mentioned to a few celebrated anatomists, five years since in London.

When the rudiments of the temporary teeth are tolerably advanced, the internal part of the gum, or rather the upper part of each membrane destined to form one of the temporary teeth, sends off a new sac. These sacs, situated as just now described, are each at first contained in the socket of the one to which it is to succeed; and are so intimately connected with the membranes of the temporary teeth, that they cannot be separated without tearing one or both, and may be torn along with the first sacs out of the sockets *. This circumstance might have misled Dr. Nesbitt, but it is strange he did not observe the commence-

* Tab. i. Fig. 3. e. e. f

ment of the permanent sockets, which are very evident in every subject I examined, just before or at birth. These facts were observed by the ingenious Mr. Hunter, for he says *,

“ There is another pulpy substance opposite
 “ to that which we have described ; it adheres
 “ to the inside of the capsula, where the gum
 “ is joined to it, and its opposite surface
 “ lies in contact with the basis of the above
 “ described pulp, and afterwards with the new
 “ formed basis of the tooth : whatever emi-
 “ nences or cavities the one has, the other has
 “ the same, but reversed, so that they are
 “ moulded exactly to each other.

“ In the *Incisores* it lies in contact not with
 “ the sharper cutting edge of the pulp, or
 “ tooth, but against the hollowed inside of
 “ the tooth ; and in the *Molares* it is placed
 “ directly against their base, like a tooth of
 “ the opposite jaw. It is thinner than the
 “ other pulp, and decreases in proportion as

* Nat. Hist. p. 94, and 95.

“ the teeth advance. It does not seem to be
 “ very vascular. The best time for examining
 “ it is in a foetus of seven or eight months old.

“ The enamel appears to be secreted from
 “ the pulp above described, and perhaps from
 “ the capsula which incloses the body of the
 “ tooth. That it is from the pulp and cap-
 “ sula, seems evident in the horse, ass, ox, sheep,
 “ &c. therefore we have little reason to doubt
 “ of it in the human species.”

Now, whether we are to understand, by the words “ the pulp above described,” that which he speaks of, as connected to the membrane of the first pulp, or the first pulp itself, he has left us quite at a loss to determine. At all events, with the nature, use, and formation of this second pulp he seems to be utterly unacquainted ; for he first leaves us, as I before said, in doubt, whether its use be to form the *cortex striatus* of the first teeth, a thing next to impossible ; and again he says, that in proportion as the teeth advance, it becomes thinner, which is actually the very reverse of what really

really happens. I need hardly add, that there are no such pulps as he describes to be found on the bases of the temporary grinders, (another inaccuracy which he has strangely fallen into,) but merely a thickening of their proper membranes.

As the fangs of the permanent teeth advance, the sockets of the temporary ones become enlarged, and little niches are formed in the internal plate of the alveolar processes answering to each socket, which are situated rather laterally, that is to say, at a greater distance from the symphysis or centre of the jaw, than the centre of each respective temporary socket *. These niches do not penetrate so deep as to the bottom of the temporary sockets, but encrease in proportion with the size of the permanent fangs, and gradually form a distinct socket round each of them. There is however, an opening left immediately under the gum, through which the membranes of both sets of teeth continue to be connected †. The pulps of the *incisores* in general are so far advanced at birth, that soon

* Tab. iii. Fig. 2. E E.

† Tab. iii. Fig. 2. e e.

after

after ossification commences on them : In a child about six or seven months old, I found their shells much more advanced than *a priori* I could have expected, and those of the *cuspидati* also had begun to ossify. The fangs of the *bicuspides* which succeed the anterior grinders had appeared, yet I did not remark those which were to succeed the posterior grinders, although those of the middle permanent grinders had already commenced *.

In a child about four years old, the bodies of some of the permanent teeth were very much advanced, ossification had commenced on the *bicuspides* †, all the points of ossification of the middle grinders were united, and the membranes of the posterior grinders or wisdom teeth were forming ‡. I have examined a number of children's jaws about this age, and found in general a similarity of ap-

* Tab. i. Fig. 5. b. b. c. c. d. d. e. Fig. 4. h. and for their connexion, Fig. 6. a b.

† Tab. ii. Fig. 2. h. h.

‡ Tab. ii. Fig. 1 and 2. and the explanation.

pearance with respect to the number of teeth which were then formed, and also those which were forming. So that I may safely say, there are more teeth formed and forming at this, than at any other period of life, that is, twenty-six teeth in each jaw.

Soon after the facts of the permanent teeth have commenced, a very curious and beautiful process takes place, for they retain their situation at the bottom of the jaw, whilst at the same time, the temporary teeth rise and appear through the gum. The alveolar processes become enlarged, or seem to rise in proportion to the elongation of the roots of the temporary teeth; so that the permanent teeth appear now considerably beneath them, and consequently the membranes which connect the permanent with the temporary teeth, are very much elongated, and appear as nervous twigs, passing up to the gum and neck of the temporary teeth. The situation as well as connexion of both sets of teeth, can be easily understood from the representations in Tab. i.

Fig.

Fig. 6. a. b. and Tab. ii. Fig. 1 2, 3, 4, and 5.

Albinus was perfectly acquainted with the *foramina* through which the connecting membranes passed, and concerning which he makes use of the following words. “ The sockets
 “ in which the permanent *incisores* are con-
 “ tained, extend to the margin of the jaw ;
 “ not far from it gradually becoming more
 “ contracted, and at length terminating in a
 “ small hole : the hole which belongs to the
 “ socket of the first *incisor*, is placed behind
 “ the first of the deciduous *incisores*, in the in-
 “ terval between it and the second : that
 “ which belongs to the second, in like manner
 “ is placed behind the second of the deciduous
 “ *incisores*, in the interval between it and the
 “ *canine* tooth. The socket of the new *canine*
 “ tooth, extending only a little beyond the
 “ bottom of the socket, in which the decidu-
 “ ous *canine* tooth is contained, thence ter-
 “ minating in a narrow little canal, before it
 “ terminates in this canal, it gradually becomes
 “ more contracted. The sockets of the new

“ jaw teeth (*the bicuspides*) do not extend by
 “ any hole to the margin of the jaw. I find
 “ these penetrate into the bottom of the de-
 “ ciduous sockets, and first indeed near to the
 “ internal part of its roots *.” Nothing can
 be more accurate than this description, but it
 has been taken from dried jaws, otherwise he
 certainly would have discovered the connect-
 ing membranes.

We have seen the membrane of the poste-
 rior temporary grinder, and that of the ante-

“ * Cavernulæ, quibus tomici novi continentur, ad
 “ maxillæ marginem pertinent, non longe ab eo fen-
 “ sim contractiores, et ad postremum in exiguum for-
 “ amen desinentes: quorum quod cavernulæ tomici
 “ primi est, id pone deciduorum primum est, ad illius
 “ secundique intervallum: quod secundi, id similiter
 “ pone deciduorum secundum, ad intervallum illius et
 “ canini. Cavernulæ caninorum novorum tantummodo
 “ aliquantum ultra fundum præsepioli, cui deciduus in-
 “ hæret, pertinentes, inde in angustum canaliculum
 “ abeunt, antequam abeant in eum, sensim contrac-
 “ tiores. Maxillarum novorum cavernulæ nullo ad
 “ maxillæ marginem foraminulo pertinent. Hos inve-
 “ nio in fundum præsepioli decidui penetrare, et pri-
 “ mum quidem juxta internam partem radicem ejus.”

Acad. Annotat. lib. ii. p. 13, 14 and 15.

rior

rior permanent grinder intimately connected together and contained in the same socket, but as the permanent grinder advances and the jaw increases in length, a process is sent backwards from the upper part of its membrane, which at first is contained in the same socket *. This process gradually swells into a sac, in which is contained the pulp, whence the middle grinder is to be formed; and as ossification advances, the parts become separated by a bony partition, the connexion however is still kept up †. When the membrane of the middle grinder is tolerably advanced, it sends off a process in a similar manner, to form the sac of the posterior grinder or wisdom tooth ‡.

I think it absolutely necessary to point out in this place some of the very great oversights and anatomical errors of Mr. Hunter; as his highly respected authority has frequently misled the unexperienced practitioner: he says §,

* Tab. i. Fig. 4. h.

† Tab. ii. Fig. 2. l.

‡ Tab. ii. Fig. 2. m.

§ Nat. Hist. p. 82 and 83.

“ The

“ The pulp of the first adult *incisor*, and of
 “ the first adult *molaris*, begin to appear in a
 “ foetus of seven or eight months ; and five
 “ or six months after birth the ossification
 “ begins in them ; soon after birth the pulp
 “ of the second *incisor* and *cuspidatus* begin to
 “ be formed, and about eight or nine months
 “ afterwards they begin to ossify ; about the
 “ fifth or sixth year the first *bicuspis* appears ;
 “ about the sixth or seventh the second *bicus-*
 “ *pis*, and the second *molaris* ; and about the
 “ twelfth, the third *molaris* or *dens sapientiæ*.”

It is evident that this description is entirely
 theoretical, and not deduced from anatomical
 observation ; for not a single point of it will
 agree with what I have already demonstrated.
 However, he has arranged his plates in such a
 manner as to make them correspond in some
 degree with his doctrine ; for instance, in Tab.
 ix. Fig. 6 *, the teeth of a child six or seven
 months old are represented, some of the tem-
 porary *incisores* were so far advanced as to

* Nat. Hist.

have nearly cut the gum; the shells of the permanent *incisores*, *cuspidati* and anterior *grinders* were a little advanced, but the *cuspidati* had not commenced in the upper jaw, yet he says, they are the teeth of a child eight or nine *years* of age. This error must surely be attributed to the printer.

But in Plate x. Fig. 1. The teeth of a child he says of five or six years of age are represented, only the anterior *bicuspidates* of the upper jaw had commenced, the middle grinders had not. In the same plate Fig. 2. the teeth of one side of both jaws of a child of seven years of age are represented; all the succeeding teeth had commenced; but even at this period the middle permanent grinders had not. He mentions, " This is an
 " age in which there are more teeth formed,
 " and forming than at any other time of
 " life," though the entire number by his calculation amounts to but forty-four. When I come to treat on the shedding of the temporary teeth, we shall find that some of the permanent *incisores* appear through the gum
 before

before seven years ; or that the roots of some of the temporary teeth, instead of being perfect as Mr. Hunter has represented them, are entirely wasted. Again in Plate xi. Fig. 2. similar mistakes have been committed, for he says, in a youth about eleven or twelve years old, the two first *molars* of the second set were so much advanced that they had cut the gums. Now these teeth in general appear about the sixth or seventh year ; and in the same plate he represents the bodies of the middle and posterior grinders only as slightly formed.

It is unnecessary to recapitulate what I have demonstrated in the commencement of this chapter. Indeed it appears as an established Law of Nature, that there should be more teeth formed and forming at four or five years of age, than at any other period of life, that is, in all fifty-two. Yet, Mr. Hunter has represented at seven years only forty-four, and at nine years forty-eight, excepting that at the latter period the middle temporary *Incisors* of the under jaw had been shed.

Although

Although I omitted saying any thing particularly respecting the formation of the permanent teeth, when treating of the ossification on the pulp of the temporary ; I think however from the observations then made *, a few words more will now suffice.

The *incisores* and *cuspidati* resemble their predecessors but are much larger, but those which succeed the temporary *grinders* differ very much from them, in size and shape, being about one third smaller. Ossification commences on them in general by two points, the shells formed round each of these points gradually unite, and ossification goes on then for some time as in the *incisores* and *cuspidati*, until the greater part of the root is formed, which commonly divides in the upper jaw into two processes near the extremity. I have met sometimes two distinct roots proceeding from the neck ; in the under jaw in general they have but one root †. Now the grinders which they succeed have four or five points on

* Vid. Chap. 11.

† Tab. iv. Fig. 14, 15, 16, 17, 18 and 19.

their

their grinding surface, and in the upper jaw they have commonly three distinct roots ; in the under jaw two. Nor, according to the celebrated Albinus, do they differ only in their number of points, but in their entire figure, by which we can readily distinguish one from the other. Although the accurate Eustachius remarks, those of the under jaw in general want the internal point *, I think the term *bicuspides*, which Mr. Hunter has given them sufficiently applicable, as it at once distinguishes them from the temporary grinders ; on which account I retain it, particularly as it has been the term made use of in practice for some years since.

As to the permanent grinders, the anterior have each five points, the middle grinders four, sometimes five points, and the posterior or Wisdom teeth three or four. In other respects their formation is exactly similar to that of the temporary grinders, but they are much larger. In the under jaw they have in general two roots,

* Tab. iv. Fig. 18.

in the upper three*, but the posterior, though they have sometimes two, three, or even four distinct roots, seem most commonly to have but one.

CHAPTER V.

Of the Increase of the jaws

IN a foetus three or four months old, the rudiments of the teeth are placed nearly regular; but as they increase more rapidly than the arch of the jaws, we find some of them at birth as it were pressed out of the circle for want of room, particularly the Cuspidati; so that the sockets of the lateral Incisores and those of the anterior Grinders nearly come in contact. However the jaws gradually accommodate themselves to the teeth, and increase at this part nearly in proportion to the size

* Tab. iv. Fig. 7 and 13.

of the Cuspidati, becoming again regular, for indeed we seldom or ever meet the temporary teeth irregular. This Mr. Hunter allows, but says *, “ The jaw still increases in all points
 “ till twelve months after birth, when the
 “ bodies of the six teeth are pretty well form-
 “ ed ; but it never after increases in length
 “ between the symphysis and the sixth tooth ;
 “ and from this time too, the alveolar process
 “ which makes the anterior part of the arches
 “ of both jaws, never becomes a section of
 “ a larger circle ; and after this time the jaws
 “ lengthen only at their posterior ends.”

Mr. Hunter supposed, as the temporary grinders are larger than the Bicuspides which succeed them, that the difference in size of these would be sufficient to allow the permanent Incisores and Cuspidati, which are much larger than their predecessors, to become regular, without any increase of the arch or circle. He was led into this opinion by comparing four lower jaws of different subjects, and at different periods of life ; from

* Nat. Hist. Page 102.

the age when the five temporary teeth are completed, to that of an entire permanent set. He acknowledges, however, that it is impossible there should be a mathematical exactness in four different jaws; nor indeed is there a mathematical exactness in the lines drawn to support his theory, for they are by no means parallel*.

Indeed so varied are the dimensions of jaws, that the arch of one a year old may correspond, or even exceed the arch of an adult; and *vice versa*, the arch of an adult may be nearly as large again as that of a child; so it is not by comparing different jaws together that we shall be enabled to draw proper conclusions; but by comparing the permanent and temporary teeth of the same jaw.

It appears from my preparations, and experience convinces me, that the space occupied by the temporary teeth would not be sufficient to accommodate the same number

* Nat. Hist. Plate 16. Fig. 2.

of permanent teeth which succeed them, and which on the whole are so much larger, particularly in the upper jaw. This fact Mr. Hunter was aware of, and mentions that irregularities are more frequently met with in the upper, than in the under jaw; so far I agree with him.

We have seen the rudiments of the permanent teeth at first placed nearly regular*, but as ossification advances on them, they become crowded together for want of room. This irregularity particularly happens to the permanent teeth, because they are at first situated at the internal part of the jaw, and of course in a much smaller circle than the temporary. As I have given an accurate representation of the jaws of a child about four years old, and the situation and connexion of both sets of teeth, in plate 2d, fig. 1st, and 2d, very little is required to be said on this subject. In the under jaw the lateral permanent Incisores hide nearly half the middle

* Tab. iii. Fig. 2. e. e. E. E. f. f.

ones,

ones, and the lateral Incisores and anterior Bicuspides are so close together, that the Cuspidati would not have near room enough to pass up between them. In the upper jaw there is a much more confused appearance, and a more striking contrast with respect to the difference in size of both sets of teeth, the lateral Incisores rest in part on the middle ones, and the sockets of the lateral incisores and anterior Bicuspides nearly come in contact; so that the Cuspidati are entirely thrown out of the circle*. We have seen also that the pulps and membranes of the permanent teeth were at first very small, and that the sockets were in proportion; but as the pulps enlarged and ossification advanced on them, the sockets increased likewise. It is but just, therefore to suppose, that as the teeth rise and appear through the gum, the alveolar processes should accommodate themselves to them; which indeed will presently appear to be the case. If Mr. Hunter was a Practitioner in this branch even with very little

* Tab. ii. Fig. 1. k.

experience,

experience, he must have frequently observed in children of about six or seven years of age, (if the first teeth had not already fallen), large distances between the Incisores, which at first were quite close to one another. I have seen hundreds of instances in which the four permanent Incisores appeared irregular, but in a short space of time became perfectly regular without any artificial assistance. In a preparation of Dr. Munro's, (which he was kind enough to allow me to take a sketch of,) the four permanent Incisores of the under jaw had appeared, and also the two middle Incisores of the upper, and were perfectly regular, though the temporary Cuspidati and Grinders had remained in, in the former, and the lateral Incisores Cuspidati, and Grinders in the latter * Surely then, these teeth could have gained no room from the difference in size of the Grinders and Bicuspides ; it must therefore be owing to an increase of the arches of the jaws in these parts, exactly in proportion to the difference in size of the temporary

* Tab. iii. Fig. i.

and

and permanent incisores. There is still in this case a further necessity for a considerable increase of the arches, on account of the irregular situation of the permanent teeth as well as because several of them had not as yet arrived at their full size.

The pressure of the front teeth on one another as they rise in the jaw, appears to have some effect in occasioning it to extend at certain parts, or to make the grinders move backwards, to which indeed all the teeth have a tendency. I have a preparation of the upper jaw of an adult, in which the temporary cuspidatus of the right side remained in; the permanent cuspidatus probably from the resistance of the former, penetrated at the internal part of the mouth; in the left side the teeth are all perfectly regular: on comparing the situation of the anterior permanent grinders, I found that of the right side nearer the symphysis, than that of the left in proportion to the difference in size, of the temporary and permanent cuspidati. I have met several instances of the permanent cuspidati appearing

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at

at first irregular, as they most commonly appear later than the bicuspidæ, but in ten or twelve months after the jaw increased sufficiently, so as to allow them to become regular. I have met many cases where the arches of the jaws continued to increase, even after the permanent teeth were complete; so that all the front teeth were quite separate from each other; and in one case the middle incisors were nearly half an inch asunder, though there was no defect in the palate.

From what is now said I feel myself justifiable in concluding, that the alveolar arches continue to increase during the entire progress of the formation of the teeth; it is however sufficiently evident, the greatest increase of the jaw is backwards. I do not by any means deny but that we frequently meet with disproportion between the jaws and teeth, and such that the permanent teeth never would become regular without the assistance of art, even in young persons; this may arise from the resistance of the temporary teeth, or from teeth forming so much out of the circle that
they

they have not sufficient power to act on their neighbours and press them back, such as the cuspidati, which are most commonly irregular. Indeed if Mr. Hunter's hypothesis were true, we would never see a regular set of teeth.

CHAPTER VI.

Of the shedding of the temporary teeth, and of the period at which the permanent appear.

WE meet with such strange opinions in the works of a celebrated author (Van Swieten) respecting the temporary teeth, that I think it worth while to insert some extracts from them: He says " I have taken out and
 " examined several of the first teeth when
 " they begin to loosen, and in most of them

“ I did not observe the slightest appearance
 “ of a root. This surprized many surgeons,
 “ who, in the treatment of disorders of the
 “ teeth, were esteemed exceedingly skilful.
 “ They were of opinion that the teeth which
 “ are usually shed about the seventh year have
 “ had roots, but when they took out those
 “ that were already loose, they found no
 “ roots. To account for this, they said that
 “ the second tooth while it rises, rubs away the
 “ roots of the first, and so reduces them to the
 “ most minute powder, which, being so very
 “ fine entirely disappears, for no body could
 “ ever perceive it. But could the action of
 “ the second tooth gently rising, whilst it
 “ moves the first out of its place, be so great
 “ as to reduce the roots of them to powder?
 “ Bourdet, celebrated for his skill in this
 “ branch of surgery, asserts, that the first teeth
 “ before they loosen have roots nearly as
 “ strong and hard, as the second are observed
 “ to have. And whilst he refutes the opi-
 “ nion of Bunon, who supposed the roots
 “ of the first were destroyed by the friction of
 “ the

“ the second teeth when rising, he refers to
 “ those which are found in the jaws of fresh
 “ subjects, at that period when the second teeth
 “ are forming ; and the first (called milk teeth)
 “ are still in their sockets ; whether they are
 “ still firm, or are more or less loose. For it
 “ seems that the second tooth whilst it rises,
 “ remains enclosed in its proper membrane,
 “ until it is about to appear. Therefore a
 “ membrane is interposed between the roots
 “ of the milk tooth and the second tooth.
 “ However the roots of the milk teeth are
 “ destroyed before the second teeth can touch
 “ them. Besides a small space is observed
 “ between the first and second tooth, from
 “ whence Bourdet concludes, that the roots
 “ of the milk teeth are destroyed by some
 “ other cause, and not by the friction of the
 “ succeeding teeth. He therefore thought
 “ that some acrid humour was secreted from
 “ the neighbouring parts, which might con-
 “ sume their roots. I must confess it ap-
 “ pears to me much more probable, that the
 “ milk teeth are without roots.

“ Nevertheless

“ Nevertheless some observations seem to
 “ shew that the milk teeth, if they are not
 “ shed at the proper period, or when loose
 “ are not taken out, are capable of protrud-
 “ ing roots from their body, by means of
 “ which they often remain fixed in the jaws
 “ through life *.”

It

* “ Plures dentes primos, dum vacillare incipiunt,
 “ eductos examinaui, et in plurimis ne vestigium
 “ quidem radicis inveni. Mirabantur hoc chirurgi per-
 “ itissimi, qui in dentium morbis curandis versatissimi
 “ merito habebantur. Statuebant, dentes, qui circa sep-
 “ timum annum cadere solent, radices habuisse : dum
 “ illos, jam vacillantes, levissimâ vi educebant, nullas
 “ radices inveniebant. Ut hoc explicarent, dixerunt,
 “ secundum dentem, dum assurgit, atterere radices
 “ prioris, et sic comminuere in minutissimum pollinem,
 “ qui præ tenuitate suâ evanesceret totus ; nam nemo
 “ illum unquam invenit. An lentè ascendentis dentis
 “ secundi, dum primum loco movet, actio tanta esse
 “ potuit, ut prioris radices in pollinem comminueret ?
 “ Egregius in hac chirurgiæ parte *Bourdet* statuit,
 “ primos dentes, antequam vacillent, habere radices
 “ æque fortes sere, et duras, quàm observantur in se-
 “ cundis

* Comment. Vol. XIV. pag. 743. et seq.

It is almost superfluous to mention that the temporary teeth have as perfectly formed roots as the permanent, indeed as far as I re-

“ cundis. Dum autem refutat sententiam *Bunon*, qui
 “ statuebat, radices illas a frictione ascendentis dentis
 “ secundi destrui, provocat ad illa, quæ in recentis
 “ cadaveris maxillis inveniuntur, dum secundi dentes
 “ jam ossei fieri incipiunt, et primi dentes, (lacteï dicti),
 “ adhuc adsunt; *sive firmi adhuc hæreant*, sive jam plus
 “ minùsve vacillare inceperint. Apparet enim, dentem
 “ secundum, dum assurgit, suâ membranâ involutum
 “ manere, donec exitui proximus sit. Radicibus ergo
 “ dentis lactei et assurgenti denti secundo interponitur
 “ membrana. Radices tamen dentium lacteorum de-
 “ structæ jam sunt, antequam secundi dentes illas tan-
 “ gere possint. Præterea parva distantia observa-
 “ tur inter dentem primum et secundum; unde con-
 “ cludit, radicem dentis lactei consumi ab aliâ causâ,
 “ non verò per attritum dentis suppositi. Hinc maluit
 “ credere, ab adjacentibus partibus secerni acriorem
 “ quemdam humorem, qui illas radices consumeret. Fa-
 “ or quòd mihi longe probabilior videatur opinio, quæ
 “ statuit dentes lacteos carere radicibus. Videntur tamen
 “ observationes docere, quòd dentes lactei, si non ca-
 “ dant suo tempore, aut jam vacillantes non eximantur,
 “ apti sint, ut radices protrudant ex suo corpore, quibus
 “ postea fixi in maxillis hærent sæpe totâ vitâ.

collect

collect, Van Swieten is the only person who at all doubted the fact.

Mr. Hunter ingeniously observes,* “ An
 “ opinion has commonly prevailed, that the
 “ first set of teeth are pushed out by the
 “ second; this, however, is very far from
 “ being the case: and were it so, it would be
 “ attended with a very obvious inconvenience;
 “ for were a tooth pushed out by one under-
 “ neath, that tooth must rise in proportion to
 “ the growth of the succeeding one, and stand
 “ in the same proportion above the rest.”

Mr. Hunter, however, does not seem to be acquainted with the writings of the very accurate Albinus; if he was, he would be induced to give a very different description of what takes place, with respect to the wasting of the roots of the temporary teeth and the appearance of the permanent, as will appear from the following quotations. Mr. Hunter says †, “ It would be very natural to suppose
 “ that this wasting was owing to a constant

* Nat. Hist. page 98.

† Nat. Hist. page 98 and 99.

“ pressure

“ pressure from the rising teeth against the
 “ fangs or sockets of the first set : but it is not
 “ so ; for, the new alveoli rise with the new
 “ teeth, and the old alveoli decay in propor-
 “ tion as the fangs of the old teeth decay,
 “ and when the first set falls out, the succeed-
 “ ing teeth are so far from having destroyed,
 “ by their pressure, the parts against which
 “ they might be supposed to push, that they
 “ are still inclosed, and covered by a complete
 “ bony socket. From this we see, that the
 “ change is not produced by a mechanical
 “ pressure, but is a particular process in the
 “ animal œconomy.” And in page 100, he
 makes use of the following words, “ When
 “ the *incisores* and *cuspidati* of the new set are
 “ a little advanced, but long before they ap-
 “ pear through their bony sockets, there are
 “ small holes leading to them on the inside,
 “ or behind the temporary sockets and teeth ;
 “ and these holes grow larger and larger, till at
 “ last the body of the tooth passes quite through
 “ them.” Mr. Hunter supports this theory
 still farther in page 90. Sc. “ As the body
 “ of

“ of the tooth is pushed out, the socket at
 “ the same time contracts at its bottom, and
 “ grasps the neck, or beginning fang, adheres
 “ to it, and rises with it, which contraction
 “ is continued through the whole length of
 “ the socket as the fang rises ; or the socket
 “ which contained the body of the tooth,
 “ being too large for the fang, is wasted or
 “ absorbed into the constitution, and a new
 “ alveolar portion is raised with the fang.”

These observations of the ingenious Mr. Hunter are however entirely hypothetical and do not accord with anatomical truth ; indeed they entirely overturn some of his former opinions. For if, as he affirms, the permanent teeth were formed, at the internal part of the jaw and in a new series of alveolar processes, it is evident that they must necessarily be placed in a smaller circle than the temporary teeth. And if the processes and sockets of the temporary teeth, as Mr. Hunter asserts, were absorbed or totally destroyed, the permanent sockets should extend to the anterior part of the jaw, accommodate themselves

to

to the teeth and thus form a segment of a larger circle*.

Albinus however comes very near the truth, for when speaking of the holes by which the connexion between the membranes of the permanent and temporary teeth were preserved, he says, “ As the new teeth increase, the contracted part of the sockets is gradually dilated, and afterwards in like manner the little opening, and thus they appear.— But if previous to the formation of the new teeth, the temporary had fallen out, or were loosened in consequence of their roots being wasted, then the socket of the temporary tooth is gradually destroyed, while that of the other being dilated anteriorly, the new tooth passes into its place, so that the root of the new tooth is contained in a socket formed partly of that in which it was before, and partly of the socket which belonged to the temporary tooth. But if contrary to what commonly happens, the tooth

* Vid Chap. v.

“ which

“ which ought to be shed, is not shed, then
 “ the permanent tooth appears behind it and
 “ remains similar to it fixed in its own ap-
 “ propriate socket *.”

Had Albinus been acquainted with the use of the small holes leading to the permanent teeth, he would immediately have discovered what usually takes place.

I have already shewn that the temporary and permanent teeth were about the fourth year, separated from each other by a bony partition, each tooth being at this period con-
 tained

* “ Crescentibusque novis, sensim dilatatur cavernula-
 “ rum pars illa contractior, posteaque et ostiolum : ac sic
 “ erumpunt. Si autem, novi antequam nati sint, de-
 “ cidui ceciderint, aut perdita radice plane vacillent,
 “ tunc sensim simul deletur decidui præsepiolum, no-
 “ vique cavernulâ antrorsum dilatâtâ, hic in locum
 “ illius succedit ut ex novi cavernula, parteque præsepioli
 “ decidui, præsepiolum, quod novi radicem contineret,
 “ formaretur. Sed si quando non decidit is, qui cadere
 “ debuit, tunc novus pone eum nascitur, suo inhærens
 “ præsepiolo, ut prior ille.” Acad. Annot. lib. ii. pag.
 14 et 15.

tained in a distinct socket. Now according as the permanent teeth rise, they have a natural tendency to come more and more to the anterior part of the jaw; whilst in consequence of the pressing forward of the rising tooth, a change is induced in the mode of action of the surrounding vessels, such, that that portion of the bony partition immediately pressed upon, as well as the root of the temporary tooth, with the adjacent parts, become fit to be absorbed, and actually are absorbed.

In some cases part of the roots of the neighbouring temporary teeth, are absorbed; particularly where the jaw does not increase as rapidly as the permanent teeth. So that in proportion as this absorption takes place, the permanent tooth passes partly into the socket of the temporary tooth proper to it, and partly into the sockets of the neighbouring temporary teeth. And as Albinus justly remarks, a socket is formed for the reception of the root of the new tooth, in part, by its own appropriate socket, and in part by the temporary

porary socket of the tooth with which it was originally connected, and sometimes in part by the neighbouring temporary sockets *. When the permanent teeth pass into the cavities which surrounded their membranes, they are always very irregular and appear as Albinus remarks at the inside of the temporary teeth, which frequently remain in their situation †. This irregularity however is seldom the case, unless where the temporary teeth retain their roots, and resist the influence of the permanent. In some cases they appear more internally than the cavities through which the connecting membranes passed ‡. It is worth remarking, that when the temporary teeth fall out, if we examine their bodies, we find them quite excavated, and the bony part reduced nearly to its former pulpy state §.

Mr. Hunter, in support of his theory, has represented the wasting of the roots of the tem-

* Tab. iv. Fig. 32. and 35. This fact is very beautifully exemplified in a preparation of the head of a young horse in my possession.

† Tab. iv. Fig. 34. b. d.

‡ Ibid. Fig. 33. b.

§ Ibid. Fig. 29. a.

porary

porary teeth, as it were proceeding from the point gradually upwards to the neck *. This, however, is seldom or never the case, for the part first affected is considerably above the point; how this takes place will be easily understood by viewing plate 11. fig. 5. and plate iv. fig. 26. 27. and 28. This circumstance Albinus was fully aware of, and has given drawings to illustrate it †.

With respect to the appearance of the permanent teeth, Dr. Hudson in a letter he wrote to me at Edinburg, judiciously remarks, “ The time of shedding is very various, happening a year or two or three earlier or later in some than others; and in many subjects some of them remaining to adult or even old age; and this is so common, that almost every day I meet with them, from one to three or four, or double the number, in the same person. I have seen two instances where scarcely

* Nat. Hist. Plate xv.

† Acad. Annot. lib. 11. Tab. ii.

“ any of them fell, and such I may affirm
 “ must have been those historic facts handed
 “ down to us, of a third set appearing in the
 “ old age of heaven-favoured mortals, where
 “ it could be nothing else than the then
 “ matured second set. Such I have met with,
 “ but never any thing like a third set, at
 “ least, which I was convinced was such.”

It appears from the foregoing observations,
 that the permanent teeth, whilst they are rising
 in the jaw, have considerable influence with
 respect to the wasting of the temporary roots ;
 for while they are at rest, the roots of the
 temporary teeth are not wasted. However,
 it does not appear to me, that the wasting of
 the temporary roots, is in any degree the ef-
 fect of mechanical trituration, as Mr. Bunon
 and other authors would affirm.

In general, children begin to shed their
 teeth about six or seven years of age, and the
 permanent appear nearly in the following
 order : First the middle Incisores of the under
 jaw, soon after, those of the upper ; then the
 lateral Incisores of the under jaw, and nearly
 at the same time the anterior Grinders ; then
 the

the lateral Incisores of the upper jaw appear, though some time elapses between their appearance and that of the former: the anterior Bicuspides appear about the 9th year, the posterior about the 10th or 11th, and the Cuspidati and middle Grinders nearly at the same time, that is about the 12th or 14th year, and finally, the posterior Grinders or wisdom teeth from the 16th to the 25th year. Though, as Dr. Hudson remarks, there are many exceptions to this general rule, yet I do not think it necessary to dwell so much on the order or period of their appearance, as I have done with respect to the temporary.

The anterior permanent Grinders frequently appear a considerable time before any of the temporary teeth are shed, and there are many varieties with respect to the wisdom teeth, for in some cases they do not appear till a very late period of life, sometimes they appear in one jaw and not in the other, and sometimes it has been observed that in extreme old age they have not perforated the

F

sockets.

sockets. It is certainly a curious fact, how very long some of the permanent teeth remain within the jaws, without appearing ; and if there ever was a third set of teeth, it is sufficiently evident, that their rudiments must have been deposited, previous to the appearance of the second set through the gum.

CHAPTER VII.

A few practical observations respecting the Temporary Teeth.

I apprehend that Mr. Hunter's theory respecting the increase of the jaws, has led him and those who followed his directions, into egregious practical errors ; he makes use of the following words* : “ From the manner

* Nat. Hist. Page 106 and 7.

“ in which the teeth are shed, it is evident
 “ that drawing a temporary tooth, for the
 “ easier protrusion of the one underneath,
 “ will be of no great service; for in general
 “ it falls out before the other can touch it.
 “ But it is often of much more service, to
 “ pull out the neighbouring, or adjacent
 “ temporary tooth; for we must be convinc-
 “ ed by what has been advanced with re-
 “ gard to the changes in size, that excepting
 “ the whole were to shed at the same time,
 “ or the order of shedding, viz. from before
 “ backwards, were to be inverted, that the
 “ second set of *Incisores* and *Cuspidati* must
 “ be pinched in room, till the Grinders are
 “ also shed: and therefore we find it often
 “ of use to draw a temporary tooth, that is
 “ placed further back; and it would, per-
 “ haps, be right upon the whole, always to
 “ draw, at least the first Grinder; and, per-
 “ haps, some time after, the second Grinder
 “ also.”

I need scarcely observe that this mode of treatment is altogether improper. The prac-

tice which Dr. Hudson of this city introduced nearly forty years ago, and still retains, entirely coincides with my observations; he was fully aware of the increase of the jaws, which appears from these his remarks,
 “ The indiscriminate practice of drawing children’s teeth before they loosen is erroneous: the intent of making greater room for the second set is thereby directly defeated. Let the propriety be hence inferred of a timely and regular domestic attention to the teeth and gums, it will prevent many painful disorders and operations, and leave Nature undisturbed in the production of the permanent teeth, to the great disappointment of the expecting charlatan.”

There are some exceptions, however, to this general rule; for it is necessary sometimes to remove a few of the temporary teeth: ex. gr. if the roots of these teeth are not wasted in proportion as the permanent teeth rise in the jaw, thereby affording such resistance, as to occasion them to appear at the internal part of the mouth*: or where the

* Tab. iv. Fig. 34. b.

jaw does not increase in proportion to the difference in size of the temporary and permanent teeth, by which means the permanent teeth are turned quite across in the sockets. The propriety, however, of performing such operations must be left to the judgment of the practitioner. The operations recommended by Mr. Hunter, I look on to be very injurious, for that pressure or proper degree of resistance and connexion (were the temporary teeth taken out prematurely) would be removed, which seems to me altogether necessary to the perfection of the permanent teeth.

It would be quite foreign to the nature of this essay, to enter into a description of the great variety of disease to which the teeth and gums are subject. Let us suppose, however, that some of the temporary teeth are diseased, or what is commonly called carious ; if they are so far injured as to occasion violent pain to the child, and if palliative remedies fail to give relief, we cannot hesitate about the propriety of taking them out.

out. Having already observed that the alveolar processes of the temporary teeth are not obliterated or absorbed, as Mr. Hunter supposed, we should be very careful lest diseases of these teeth or gums should materially injure them, which indeed is too often the case. When the caries of a tooth has proceeded so far as to communicate with the cavity where the vessels are contained, the ichorous matter, or the air admitted into the cavity coming in contact with the membrane of the pulp, occasions an inflammation of it, which frequently communicates with the external periosteum of the root. When the inflammation has advanced to a certain degree, suppuration takes place, and a considerable sac or abscess is thus formed*, which being filled with purulent matter, occasions an absorption or wasting of the alveolar process near the apex of the root, and in this way a passage is at last made through the process, forming what is commonly called a gum-boil. The opening is usually made between the

* Tab. 111. Fig. 12. b. b.

cheek and jaw, sometimes however, it bursts externally, and leaves a disagreeable cicatrix or scar through life. So that in such cases the necessity of removing the temporary teeth is obvious, in order to avoid such distressing consequences as these, and others which are even yet more particularly dangerous.

It is the opinion of many celebrated Anatomists, that diseases of the temporary teeth cannot injure the permanent, even though the diseased parts were to come into contact with them. I am sorry to say I have seen many instances of the contrary; though previous to my having observed the connecting membranes, I was totally at a loss how to account for the injuries communicated from one to the other. The following case, which occurred to me about six years ago in this city, will illustrate the subject remarkably well.

A lady brought a child to me about six years old, to have the anterior temporary Grinder of the under jaw taken out; the tooth was very much diseased, and the point
of

of one of the roots stuck out of the jaw, and occasioned an ulceration of the cheek. On inspecting the mouth, I found the tooth quite loose, and a considerable portion of the alveolar processes attached to it, which had been separated from the neighbouring or sound parts. I removed the entire with a curved probe, and having immersed the extracted portion in water, in order to examine it, I found it to consist of the entire socket of the temporary tooth, and also the socket in which the *bicuspid* was forming, part of the body of which was tolerably advanced; the earthy matter of the cortex striatus was quite black, and perfectly soft *. The sockets of the neighbouring teeth fortunately were not much injured. On enquiring into the history of this case, I was told that about two years previous the child had had a slight fit of the tooth-ache which subsided, and soon after a gum-boil was formed, which frequently suppurated and burst, after which the child would get relief for some short interval. The mo-

* Tab. III. Fig. 3. a. b. c. d. e.

ther, through timidity, or false affection for the child, could not be prevailed on to consult any one, until forced to it by the consequences already mentioned. The child without any other assistance got well, but the jaw remains very much contracted where the tooth was, with a corresponding hollow in the cheek.

I have since that period met three or four cases, where two or three of the permanent teeth were sloughed off by a similar cause. These cases I account remarkably instructive, for they clearly point out the necessity of removing the temporary teeth, when any such ulcerations or gum-boils are forming, particularly if they are of great extent, or long continued. Slight cases, however, if properly attended to, might be retarded and probably entirely checked.

The instruments I have found best adapted for such operations are those invented by Dr. Hudson *.

* Tab. 7. Fig. 2 and 3.

CHAPTER VIII.

Of the Teeth in various Classes of Animals.

AS well the structure as formation of the teeth of graminivorous and ruminant animals, differ from what is observed to take place in those of the carnivorous order. The food of the former requires a greater degree of comminution than that of the latter ; for which purpose it becomes necessary, that the surfaces, between which this operation takes place, shall be as much as possible multiplied. That this object is fully provided for by nature, may be evinced by inspecting the grinding surfaces of their teeth ; for the *Cortex Striatus* not only covers the body of the tooth, but even descends through its substance, forming therein a variety of convolutions, and of course a variety of prominences in each accidental section of it *; such parts of it being

* Tab. v. Fig. 10. and 12.

less liable to abrasion, than the other bony portion of which it is composed.

Many circumstances however, particularly relative to their structure and formation, have not been as yet at all attended to or explained, on which account I have endeavoured to trace them at different periods.

In the right side of the lower jaw of a foetus calf about three months old, the internal plate of the alveolar process being cut away, and the arteries injected, the rudiments of the teeth, their connexion with the gum, &c. appeared as they are represented in Tab. v. fig. 1.

The upper part of the pulp of a grinder is divided into a certain number of conical processes, previous to the commencement of ossification upon it; the number of these processes varies according to the size, or kind of tooth; in some there is but one, in others two, four, or six of them. The pulp of the great grinder of the under jaw in the calf just now mentioned, was divided into six processes, and
on

on it as many bony shells were already formed. In the view given of it in Tab. v. fig. 2. three only of the shells can be seen, the others were placed exactly opposite and at a little distance from them; one of the shells has been removed and is represented in the same plate fig. 3. As ossification advances, the processes of the pulp elongate, whilst the bony shells extend considerably on them previous to the junction of their sides; they then form one continued shell exhibiting no trace whatever of their former separation*. From the convoluted shape of the pulp, deep depressions are left at the junction of some of the shells, which are situated at the internal part of the mouth in the upper jaw, but at the external part in the under. In order to fill up these, or to strengthen the tooth, one or two additional processes are sent off from the pulp, when ossification has advanced somewhat on the original pulps, or when the sides of the shells have been nearly united. These processes however do not rise to an equal height with

* Tab. v. fig. v. d.

the first*, the upper teeth have but one of them, the under in general two.

The membranes which are intimately connected with or derived from the internal part of the gum, can be easily separated into two *lamellæ*, the external of which is very vascular, though I could not trace a single blood-vessel entering into the internal one†; this appearance is best examined in foetus calves about three or four months old. These membranes surround the pulp, and duplicatures of them pass down between the internal divisions of it, exactly similar to the passing of the *pia mater* between the convolutions of the brain. The duplicatures extend downwards until checked by the junction of the internal plates of the shells, which thus separates them from the pulp‡. As soon as the bony shells are perceptible, the internal part of the membrane secretes and deposits on their points and progressively on their sides, a soft earthy matter similar to moistened chalk, and is itself

* Tab. v. fig. 4. c.

† Tab. v. Fig. 6. b. b.

‡ Tab. v. fig. 7. a. a. a. fig. 5. a. a. & b. and fig. 11. d.

moistened

moistened with a mucilaginous fluid, a great quantity of which is found between the membrane and shells. This soft earthy matter gradually assumes the crystalline appearance of the *Cortex Striatus*, the fibres of which in fig. 7. are represented in contact with the membrane, the bony part in contact with the pulp.

When the cortex striatus is perfectly formed down to the bottom of the convolutions or junction of the internal plates of the shells, the tooth begins to rise by the increase of its roots ; the upper part of the investing membrane at the same time wasting in proportion as the cortex striatus covered by it attains to perfection, so that the tooth advances by almost imperceptible degrees 'till at length it appears through the gum. The protuberances of the tooth first appear, and thus intercept part of the nourishment from the duplicatures of the membrane which passed down into the internal cavities. That part of the tooth marked a. a. in fig. 8. had passed through the gum still however fibres of it passed between the convolutions of the shell into the hollows, by
which

which the membranes in them were still in some degree supported ; the gum is turned up and fibres of it are represented as if passing down into the cavities. When the tooth rises somewhat higher, all nourishment is cut off from the internal duplicatures of the membrane which are then found dead and of a darkish purple colour*. The lower part of the membrane however remains on the external plates of the body of the tooth†, but is wasted in proportion as the cortex striatus becomes perfect. The entire bodies of the temporary teeth when formed pass through the gum, so that the whole of the investing membrane is destroyed as soon as they have risen to their proper height. This description however admits of a few exceptions, particularly with regard to the permanent grinders, the greater part of whose bodies remains within the jaw for a considerable time. A purpose of some consequence in the animal œconomy, which I shall presently endeavour to explain, is thus answered ; and, as the process by which it is completed is very different from what has been

* Tab. v. fig. 9. a. a. a.

† Fig. 8. c. c.

already

already described, it will be of use to point it out in the clearest manner.—It appears that the internal part of the membrane secretes the earthy matter of the cortex striatus, and that as soon as it has performed its function it is wasted or destroyed ; for its external lamella, as soon as the upper part of the cortex striatus is crystallised, begins to deposit on its surface a substance differing from either the bony part or the cortex striatus, being harder and more brittle than the former, and less so than the latter. It is likewise of a different colour and can be readily distinguished from the other two component parts. As the surface of the cortex striatus is smooth, this substance (which for distinction's sake, I take the liberty of calling the *Crusta petrosa*) cannot adhere firmly to it, and for this reason in the teeth of young animals it easily chips or scales off, when they are exposed to the weather. In animals more advanced in life, the *Crusta petrosa* fills up all the convolutions of the external plates of the cortex striatus, and extends a considerable way beyond them, so as to form a great proportion of the grinding surface*, when it becomes much more con-

* Tab. 5. fig. 10. and 12. d. d. d. d. and fig. 11. e. e-

solidated and with difficulty can be separated from the cortex striatus. The *Crusta petrosa* not only covers that part of the tooth which appears through the gum, but also that part of it which remains within the socket, and in a few instances I have observed a small quantity of it on the roots of the teeth of very old horses. From this, and observations on the teeth of other animals which will presently be mentioned, it would seem that the membrane may at once deposit this matter, without having previously given rise to the cortex striatus. The *Crusta petrosa* is depositing on the upper part of the tooth a long time previous to the crystallisation of the lower part of the external plates of the cortex striatus, and it continues to be deposited as long as any part of the body of the tooth remains within the socket.

The *Crusta petrosa* seems intended to serve a variety of purposes : in the first place, to fill up the hollows in the sides of the teeth, next the cheek and tongue, and render them even. 2dly. To support and prevent the fibres of the cortex striatus from splintering off or wearing

G
down

down too rapidly. 3dly. To increase the grinding surface and render it more rugged, for it scarcely wears down as fast as the bony part, yet faster than the cortex striatus. In some few instances the Grinders remain sufficiently long under the gum, so as to allow the cavities, in which the membrane passed down to form the cortex striatus, to be nearly filled by the *Crusta petrosa*. In most cases however, these cavities are filled entirely with the matter of the food, by the broken particles of the teeth whilst grinding, or by particles of sand, clay, &c. This adventitious matter remains quite spongy and of a different colour and texture from any of the other three above described parts ; in the cow it is of a blackish or dark-brown colour*. It is remarkably evident in the Grinders of the sheep, in which the cavities are constantly filled with particles of grass and clay ; the structure and formation of their teeth being similar to those of the cow, except what regards the additional processes.

The

* Tab. v. Fig. 10. b. b. b. and Fig. 11. b.

The *Crusta petrosa* seems intended for another and a very important purpose. The greater proportion of the cortex striatus in graminivorous animals as already mentioned remains within the jaw for some years. Now the nature of this substance is such, that membranes could not adhere to it, whilst without the interposition of some such substance as the *Crusta petrosa*, or a total want of the cortex striatus, a circulation of fluids through the socket could not take place. The *Crusta petrosa* is therefore deposited for the membranes to adhere to, and also to prevent the sockets being injured by the violent motions performed in grinding. It cannot be mistaken for a deposition from the fluids of the mouth commonly called *Tartar*, for I just now mentioned that it is deposited previous to the appearance of the tooth through the gum. A similar substance I have observed on the Grinders of the Elephant*, Rhinoceros, &c. and even on the Grinders of the Rabbit and Hare, indeed it is to be met with in almost all graminivorous animals.

* The structure and formation of the Elephants' teeth I reserve as a supplement to the present work.

The Grinders of the camel are nearly similar to those of the cow, the internal cavities of their teeth are in like manner filled with particles of grafs, clay, &c.

The formation of the Incisores and Grinders of the horse differs very much from those of the cow, and probably from those of all ruminant animals ; for, as the horse does not chew the cud, it was necessary his food should be at once sufficiently masticated ; his teeth and jaws of course are admirably fitted for this purpose.

The Grinders of the upper jaw commence by four points of ossification, and are formed precisely similar to those of the cow, except that additional processes are not added, and that the internal cavities are mostly filled by the *Crusta petrosa* ; although I have sometimes observed the upper part of the cavities filled by the adventitious matter, as represented in Tab. v. Fig. 12. b. b. while the under part of them was occupied by the *Crusta petrosa*. This only happens where the ossification of the roots takes place more rapidly than the deposition

fition of the *Crusta petrosa*, so that by the tooth penetrating the gum the nourishment is cut off (as already mentioned *) from the internal duplicatures of the membrane.

The formation of the Grinders of the under jaw, however, differs very much in those animals; for though ossification commences in the horse on the pulp of the Grinders, by five or six points, which afterwards increase into as many small shells, yet, as happens in the human subject, they unite without duplicatures of the membrane passing down between them to form internal plates of the cortex striatus, which I before observed always takes place in the cow. This membrane however passes round the pulp in a very convoluted manner, and as the points of the shells and the interstices between them are soon worn away by grinding, a section is thus formed in which one continued line of the cortex striatus can be traced including the bony part alone within it, the *Crusta petrosa* remaining without †. In

* Vide Page 83.

† Tab. 9. Fig. 5 and 6.

all graminivorous animals the under jaw is much narrower than the upper, particularly at the anterior part, the under teeth are likewise at least one third narrower, but by the lateral motion of the under jaw during manducation, different points of the under teeth can be successively applied to the whole surface of the upper ones, the lateral motion corresponding exactly to the difference in breadth of the upper and under teeth.

The pulp of a front tooth in either jaw of a horse is divided into two processes : duplicatures of the investing membrane pass down between them to a considerable depth, even greater than is represented in Tab. v. Fig. 7. a. which conveys an adequate idea of the section of one of these teeth whilst forming.—The cavity in the middle of each of these front teeth is filled by particles of the food, &c. and sometimes, though seldom, by the *Crusta petrosa*. By the disappearance or wearing down of the edges of these cavities and internal plates of the cortex striatus, jockies determine the age of a horse, or (in their language)

guage) by the filling or growing up of the cavity. Indeed so well acquainted are they with this circumstance, that when the natural cavities disappear, they form artificial ones, and fill them with a composition of resin, clay, &c. to make them appear black, but such fraud can be easily detected by observing whether there is a plate of the cortex striatus bordering the cavity, or not. This method, as well as observing the period at which foals cut or shed their teeth, must be rather fallacious; the first depending so much on the quality of their food as will presently be shewn; and the second depending in a great measure on the constitution of the animal.

It is rather a curious circumstance that horses have 40 teeth in both jaws, and mares have only 36, the Cuspidati commonly called tusks being wanting in the latter; though their rudiments are formed in the jaws, they seldom or never appear, and if they do, as the celebrated Buffon remarks, they are scarcely discernible.

As

As the cow, sheep, &c. have no front teeth in the upper jaw, it was necessary that the edges of those in the under should be very sharp ; the membranes of course do not pass down into the internal bony part of them, but they are formed as single teeth in general are.

Eustachius, although he did not investigate the subject fully, was aware of many circumstances relative to it, which I cannot pass over in silence. He says, “ The situation of
 “ the human teeth is at the extreme edge of
 “ the circle of both jaws. In some of the
 “ brute creation however, and in almost all
 “ fishes, their seat is in the palate, the
 “ tongue and even the stomach. Those ani-
 “ mals which ruminate, we are told by all
 “ anatomists, have only an inferior range of
 “ teeth, in which however they are incorrect,
 “ for they do not want the entire of the up-
 “ per teeth, but those only which should lie
 “ in front *.” When speaking afterwards of

* “ Humanorum dentium sedes est extremus tantum
 “ utriusque maxillæ ambitus ; quamquam multis bel-
 “ luis,

ruminant

ruminant animals, he describes that peculiarity of formation in their teeth, by which they become liable to contain heterogeneous particles, those especially of the food on which they are nourished *.

All the points of those teeth which we have been examining, had been at one time covered by the cortex striatus, and the plates of it were all at that time intimately connected, so that one continued line of it could be traced as in Tab. 5. Fig. 7. It is evident, that in proportion as the cortex striatus is worn off these points, the bony matter must appear between its plates, therefore in Fig. 12. the *Crusta petrosa* is observed externally, then the cortex

“ luis, sicut fere cunctis piscibus, palatum quoque ac
 “ lingua, et nonnullis aliis venter, pro sede sunt; et
 “ quæ ruminant, ut anatomici omnes scribunt, inferi-
 “ orem tantum ordinem dentium habent, quod tamen non
 “ ita intelligendum est, ut quispiam hoc sermonis genere
 “ deceptus putet, eas superioribus dentibus prorsus ca-
 “ rere, sed illis tantum, qui ad superius labrum perti-
 “ nent.”—Opusc. de Dent. Page 9.

* Ibid. Page 56.

striatus

striatus, within which is the proper bony part, including again two plates of the cortex striatus, and in the middle of these the cavities filled by the food, &c. so that this tooth consists of four different substances.

Mr. Hunter mentions in the description of Plate xiv. Fig. 19. Nat. history. "The enamel passes through the whole length of the tooth; the enamel is represented by the white lines which are penniform." It appears strange that Mr. Hunter should fall into such an error, nor can I conceive how he could, unless by a section similar to the one represented in Plate v. Fig. 7. c. where the plates of the cortex striatus approach so close to each other, that at first sight they appear penniform, but on closer inspection there are bony lamellæ observed between them, on which the fibres of the cortex striatus are arranged. Mr. Hunter's figure one would think had been drawn from an imaginary preparation, for in whatever direction a section were made, the appearances would have been different from what he has represented.

The

The windings, fibres and termination of the cortex striatus are accurately represented in Fig. 7. and 11. of the same plate. The fibres pass upwards in an inclined direction towards the grinding surface, by which means the entire fibre is not broken off at one time, and of course the teeth last longer than they otherwise would. When we split or break a tooth of these animals, a beautiful silvery line is observed at the junction of the cortex striatus and the bony part, as I have endeavoured to show in Fig. 11.

According as the grinding surface of these teeth is worn down, (by the addition of bony matter to their roots and filling up of the sockets,) they rise in proportion, and continue to rise until all the plates of the cortex striatus are worn away, and even the roots. Sometimes they wear or are rubbed away very irregularly; I have seen an instance where a middle Grinder of the upper jaw was protruded near an inch lower than any of the others, and had worked a groove for itself between the lower teeth. I have several instances in my posses-

on less striking, all of which must have been very troublesome and detrimental to the poor beasts, and might probably have been prevented by a judicious operation.

With respect to the connexion of the temporary and permanent teeth, I have found it in all animals I have examined, similar to that already mentioned as subsisting between those of the human.

Those animals that make use of their teeth as edged tools for cutting or scraping very hard bodies, such as the squirrel, rat, &c. are supplied with two Incisores in each jaw, most admirably adapted for these purposes. As the under Incisores are principally made use of, they are nearly twice as long as those of the upper ; and indeed they are much longer than *a priori* I could have imagined, for they occupy the greater part of the jaw from the symphysis to the roots of the coronoid processes. In the under jaw of the squirrel for instance, the Incisores form almost a semicircle, and the Grinders are situated within the segment

ment of the circle *. In the upper jaw they form a segment of a much smaller circle, and do not extend even so far as the anterior Grinder.

The bodies of their Grinders are covered by the cortex striatus ; but it is deposited only on the convex surface of the Incisores, so that the extremity with which they gnaw consists entirely of the cortex striatus. The flattened sides and concave surface are bone, in order that the external membrane might adhere to it and nourish the tooth, and also the bone being much softer than the cortex striatus, it is more easily worn down, by which means the cortex striatus is always prominent and retains a most acute edge †. The edge itself, hard as it is, is constantly wearing away ; but in proportion to its waste, the tooth is protuded by the addition of new ossific matter to its base, and the curve of the tooth is such that the edge of it always preserves exactly the same situation with respect to the upper teeth.

* Tab. 3. Fig. 9. a. a. a. and c. c. c. &c.

† Ibid. b. b.

By the curved form the teeth acquire additional strength and are less liable to be broken than they otherwise would be. The squirrel I have just now spoken of, was domesticated, and used to amuse himself in chewing ivory which happened to be inlaid in some pieces of furniture.

The structure and formation of the Incisores of the beaver are precisely similar to those of the squirrel and rat, and the colour of the cortex striatus is likewise nearly similar, being an orange or deep yellow. But there is a marked difference between the formation of their Grinders, for, as I just now mentioned, those of the squirrel and rat are covered by the cortex striatus, but in the beaver it passes in a very convoluted manner round the bony part, as in the under Grinders of the horse, so that when the upper part of the tooth is slightly worn down, one continued line of the cortex striatus can be traced *. Sometimes however an additional point is observed unconnected with the line

* Tab. 9. Fig. 3. c. d. e.

of the cortex striatus on the surface as at f.—
 The *Crusta petrosa* fills up the external spaces left by the windings of the cortex striatus.—
 This structure is admirably contrived and fitted to the purposes of the animal ; for its food, (as Buffon mentions) being principally the branches of trees, &c. it could not otherwise grind it sufficiently ; and to supply the consequent waste of the upper surface of the tooth, new ossific matter is continually adding to the base, which appears hollow and convoluted as represented in Tab. 9. Fig. 4. b. without any appearance of roots being formed, which probably never are formed. We can easily conceive how they can cut down large trees, as mentioned by most historians, with such powerful instruments as their Incisores *.

The Incisores and Grinders of the rabbit and hare, are formed in a similar manner to those of the beaver, but the Incisores even in the under jaw do not extend further back than the anterior Grinder, and although the cortex striatus is similarly situated on them, it is of a different colour, being white. It is worth ob-

* Tab. 9. Fig. 3. a. a. a.

serving,

serving, that in these animals, (scil. the rabbit and hare) there are two small teeth situated at the internal part of the Incisores, both in the upper and under jaw, which scarcely appear above the level of the gum.

From the foregoing observations, as well as many others, it appears that the Incisores of all such animals are never shed, but augment in proportion to the increased size of their jaws. Hence arise the various breadth and curvature of these teeth at different periods, and probably the protrusion of the tooth is owing to the continued growth of the bony matter from the surface or membrane of the pulp. Also on the peculiar curvature the safety of the softer or growing parts depends, the pressure being confined to the prominent part of the tooth near the anterior part of the jaw, or towards the middle of the curve.

I have observed in all cases where a great portion of the cortex striatus was contained in the socket, and where the *Crusta petrosa* would have been rather an inconvenience, portions of
the

the bony part left without a covering of the cortex striatus, in order that the tooth might be nourished, and that part only covered by it which was intended for use, or exposed to injury. In some animals the *Crusta petrosa* alone is deposited on their teeth, such as the spermaceti whale, whose teeth are confined to the lower jaw.

I have observed a very beautiful contrivance, with respect to the different ranges of teeth with which some genera of fish are provided, for instance the skate, in one species of which the teeth are spear-pointed, and their points turned towards the throat ; their chief use seems to be, to enable the animal to retain its prey, or to crack the shells of lobsters, crabs, &c. which are probably its chief food. Although their teeth are covered by a very hard cortex striatus, they are nevertheless liable to be broken or worn down, by the shells of the animals they make use of. Nature however has wisely guarded against premature old age, by continually forming several ranges of teeth, so that as one or more of the front ranges are

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destroyed

destroyed or naturally shed, the lower ranges advance forward and supply their place.—How this circumstance happens I will now endeavour to explain: their teeth are not fixed in bony sockets, but attached to a cartilaginous or ligamentous matter which rests on the jaw. Each tooth has two processes or roots, and each root has a deep furrow near the neck *, by which means it is more firmly connected, and as the front ranges are shed, the cartilaginous matter is by some process in the economy of the animal drawn forward, and with it the teeth, new ranges still continue to form, I may say *ad infinitum*, while the same process continues to take place. These facts can be easily understood by viewing Plate vi. Fig. 1. in which two or three of the front ranges are represented broken or worn down, three or four of the ranges immediately under them are perfect and turning up to supply the place of the former, and although this was a very old animal, yet several ranges can be observed imperfect, covered with their proper

* Tab. vi. Fig. 2. b.

membranes,

membranes, and the earthy matter of the cortex striatus was quite soft on them.

A contrivance somewhat similar is observed in the common shark, whose teeth are spear-shaped, serrated at their edges and covered by a cortex striatus as hard as that of the former animals. These animals are said to live to a very great age, and from the nature of their food, as well as the accidents they are exposed to, their teeth are constantly in danger of being broken or torn away ; to guard therefore against such prejudicial effects, several ranges of them are formed and constantly forming. The upper range is placed nearly perpendicular on the margin of the jaw *, the under ranges are regularly disposed quite flat one over the other, and their points are turned in an opposite direction to those on the margin. When therefore one tooth or range of teeth is shed or torn away, the tooth or range of teeth immediately underneath begins to turn up and pass into the place of the former †.

* Tab. vi. Fig. 5. a. a.

† Ibid. Fig. 5. c.

These teeth are inserted in the cartilaginous matter of the jaw, as in the skate, and are so firmly fixed in it, that the animal has not power to move them at pleasure, as was formerly supposed. The number of ranges does not seem determinate, and the under ones are quite imperfect, the earthy matter of the cortex striatus being soft on them, but they gradually become more and more perfect towards the upper range. Their connecting membranes are similar to those observed in the human body, for the membranes pass down from the upper range which is forming to the second, from the second to the third, from the third to the fourth, and so on to the 5th, 6th, or 7th.

The same appearances may be observed in the angel fish, which was said to have had but four rows of teeth, but on cutting open the membranes, I found five or six of them.

Some months after I had written this chapter of my Thesis, and mentioned the observations contained in it to many of my friends in
Edinburgh,

Edinburgh, Mr. Robert Jameson was kind enough to send me a translation from the Italian of the Abbe Spallanzani's travels he received from London. In this work I was very much pleased to find many remarks by the Abbe and other authors in support of my opinions*. He says, " we learn from Steno
 " that in the *squalus carcharias* (the shark) the
 " inner (rows of the teeth) are bent down-
 " wards, and are so enclosed in the soft and
 " fungous flesh of the gums, that unless the
 " latter be cut away, they are not visible.—
 " For what use the teeth thus bent were in-
 " tended by nature I cannot discover ; since
 " they are so buried within the flesh, that they
 " cannot serve for grinding their food. The
 " teeth in the first row may, perhaps, be de-
 " signed to prevent the prey from escaping, or
 " to divide it when too large to be received
 " into the stomach ; but why the others were
 " formed I do not see, unless we say, that they
 " have been produced by the necessary action

* Vol. iv. Page 358.

“ of matter *.” The Abbe says, page 359.—
 “ But Herissant was of a different opinion.—
 “ He found, after a very careful examination
 “ of several jaws of sharks, that the teeth,
 “ more or less covered with flesh, are teeth of
 “ reserve, to supply the place of those of the
 “ first row should they chance to be lost; in
 “ which case, these which lie below, rise out
 “ of the fungous flesh, and take the place of
 “ those that are wanting †.” “ From the
 “ examination of several sharks’ jaws, I was
 “ now satisfied that the teeth of the second
 “ row, which are bent towards the throat, are
 “ not merely ‘produced by the necessary action

* “ *Interiores (ordines dentium) inferiora versus re-*
 “ *curvati, gingivarum molli et fungosa carne ita deli-*
 “ *tescebant clausi, ut non nisi resectis gingivis in con-*
 “ *spectum prodirent. Cui usui dentes ita incurvatos*
 “ *natura destinavit, non perspicio, cum, carnes intra se-*
 “ *pulti, escæ comminuendæ nullâ ratione potuerint*
 “ *inservire. Retinendæ prædæ, ne diffugiat, forsi-*
 “ *tan et diffringendæ majori, quam quæ ventrem subire*
 “ *possit, primi ordinis inserviunt: reliqui verò, nisi*
 “ *materiæ necessitate facti, non video cujus gratiâ sint*
 “ *confecti.*”

† Mem. de l’Acad. Roy. 1749.

of

“ of matter,’ as Steno has suggested, but
 “ designed by Nature to supply the place of
 “ those of the first row, when they may chance
 “ to be lost ; as was first discovered by He-
 “ rissant ; and I flatter myself I am the first
 “ who, since he wrote, has confirmed his in-
 “ genious and noble observation *.” After
 these remarks it appears rather strange that
 the Abbe Spallanzani should doubt, that the
 teeth of every species of *shark* were intended
 to alter their situation, according as the exigen-
 cies of the animal required. For in describ-
 ing the jaws of a shark, nearly similar to that
 I have represented in Tab. vi. Fig. 5. and
 which he calls the *squalus* of Messina, he ob-
 serves † “ One of the largest teeth in the first
 “ row is wanting, being entirely detached from
 “ the jaw. This loss could not have been re-
 “ cent, when the fish was taken, as the fungous
 “ flesh had formed a scar over the place it had
 “ occupied, producing an angular elevation
 “ of some thickness. If, therefore, the second
 “ row of these teeth, and the same may be

* Page 363 and 364.

† Page 373.

“ said

“ said of the other lower rows, had been de-
 “ signed by nature to supply the deficiencies
 “ that might happen in the first, it is evident
 “ that the tooth below would have occupied
 “ the place of the tooth wanting, or at least
 “ would have raised itself up and approached
 “ nearer to it. The fact however is, that this
 “ tooth, which we might have supposed to be
 “ formed as a substitute, is by no means such,
 “ but still continues in the same position with
 “ the others, and covered in the same manner
 “ with the fungous flesh.” It is very obvious
 from the Abbe’s remarks, that the tooth he al-
 ludes to, was not perfect, being covered by its
 proper membranes, and of course at this period
 could have no tendency to rise or turn upwards;
 but most undoubtedly, if it had arrived at per-
 fection, it would have passed into the place of
 the former. Surely if one of the temporary
 teeth of a child was prematurely taken out, the
 permanent tooth underneath would not im-
 mediately rise up and supply its place.

A very singular contrivance I have observed
 with respect to the articulation of the teeth in
 the

the *Lophius piscatorius* commonly called by fishermen the sea-devil. The points of all the teeth are turned towards the throat, and each of them is joined at the internal part to an elastic cartilaginous or horny substance, which allows them to yield to the slightest external pressure, so that they afford no resistance to the animals it allures by its playfulness to enter its mouth, but the moment the external pressure is removed, the elastic springs react and press the teeth back into their original situation. The external part of the teeth form a kind of fulcrum on the jaw, and resist the pressure from the internal part so strongly, that I could not force one of them out of its situation *. The teeth placed in the stomach of this creature are similarly constructed in order to prevent the escape of its prey.

* Tab. vi. Fig. 3. and 4. and the explanation.

CHAPTER IX.

Of supernumerary Teeth, &c.

WHEN we consider the formation of the teeth and the contiguity and intimate connexion subsisting between their rudiments, we cannot be surprised to meet with such frequent deformities and varieties as occur amongst them. Though deviations in the shape or size of their bodies seldom occur, yet their roots vary considerably, some being much larger than those commonly met with, others curved in different directions, or exceeding their usual number.

Eustachius, Jussieux, Fauchard and other writers mention some instances remarkable for the singular position of the teeth in the jaws. They also speak of having met with a few cases where two or three of the front teeth and as many even of the Grinders were completely
joined

joined together by ossification. I have met with more than a dozen cases somewhat similar, for instance the bodies and roots of the lateral temporary Incisores and Cuspidati joined together, and among the permanent teeth, the middle and lateral Incisores as also the lateral Incisores and Cuspidati. Here it is evident both pulps must have been contained in the same investing membrane or sac, for their ossification is in general so complete that one hole serves to both for the admission of vessels, &c. *. In those cases the body of each of the teeth so conjoined commonly retains its own appropriate form, though both are completely surrounded by the cortex striatus †— Amongst the permanent teeth however I have met with one instance, where one of the middle and lateral Incisores were so intimately united, that on viewing them externally they appeared as one large middle Incisor, no trace being left of their having originally two distinct bodies ‡; but on the internal surface there is a very marked difference and each retained nearly its pro-

* Tab. iii. Fig. 4. c.

† Tab. iii. Fig. 4. a. b.

‡ Tab. iii. Fig. 6. a.

per shape *. Excrescences of the cortex striatus are very seldom met with, one singular instance of it occurred to me, in a patient about 17 or 18 years of age. The right permanent cuspidatus in this person did not appear through the gum until the sixteenth year, on the side of it next the lateral Incisor there was a bulbous protuberance of the cortex striatus, with a hollow or depression in the middle, this protuberance did not however extend to the apex of the tooth †. Between the bulbous part, and the perfectly formed body of the tooth, there was also a deep groove, which perhaps retained part of the investing membrane longer than usual, or the external *lamella* of the membrane was not wasted, for there was a substance somewhat similar to the *Crusta petrosa* of graminivorous animals deposited round the protuberance of the cortex striatus, and even on a considerable portion of the root. This substance stuck out and formed a sharp hook under the lip, which was very troublesome to the person, and as there was not sufficient room

* Tab. iii. Fig. 5. a. b.

† Tab. iii. Fig. 7. a.

for the tooth in the arch of the jaw, it was of course advisable to have it removed *. This is the only instance I have met with, or even heard of, where a *Crusta petrosa* was deposited on a human tooth.

With respect to the uncommon situation of the teeth in the jaw, by far the most curious case is related by Albinus of an adult in whom he found “ Two teeth, one on each side of the
 “ nose between it and the orbits of the eyes,
 “ enclosed in the roots of those processes,
 “ which extend from the maxillary bones
 “ to the eminence of the nose. They were
 “ long and remarkably thick, similar to the
 “ canine teeth and seem to have been these
 “ very teeth which had not in this case ap-
 “ peared. But there were, besides these, other
 “ canine teeth, unusually small and short, plac-
 “ ed in their proper sockets. The former
 “ seem therefore to have been the new canini
 “ which had not penetrated their sockets, on
 “ the contrary they were situate where the
 “ new ones usually are observed to be in chil-

* Tab. iii. Fig. 7 and 8. b. b.

“ dren.

“dren. But what is still more strange, the
 “points of their bodies were turned towards
 “the eyes, as if they had been the new ca-
 “nine teeth inverted, convex on the posterior
 “part, concave on the anterior, the reverse of
 “what generally happens *.”

This case fully shews the great accuracy of Albinus, he did not mistake those singularly situated canini for supernumerary teeth though he was aware that such frequently occur.

* “Dentes duo inter nasum et orbes oculorum,
 “dexter sinisterque, inclusi in radicibus processuum, qui-
 “bus ossa maxillaria ad eminentem nasum pertinent.—
 “Longi sunt, crassitudinis insignis; similes maxime ca-
 “ninis, ut videri possint illi ipsi esse, non nati. At ade-
 “rant præterea canini, præter consuetudinem parvi, et
 “breves, suis infixi alveolis. Itaque videantur esse canini
 “novi, qui non eruperint: utpote ibi loci collocati, ubi
 “sunt novi illi in infantibus. Sed, quod miremur, sursum
 “directi, tanquam si sint canini novi inversi. Et ita quo-
 “que formati sunt, ut, contra quam alii, à posteriore par-
 “te gibbi, ab anteriore sinuati sint, &c.” Acad. Annotat.
 Lib. 1. Pag. 54.

Mr.

Mr. Hunter mentions his having met with a case somewhat similar, and gives * “ a sketch of the upper jaw of a child, where the *cuspidatus* was inverted, so that its point was turned up against the jaw, and the growing mouth of its cavity towards the gum.”

Amongst the temporary teeth supernumerary ones are seldom observed. Dr. Hudson however has met with a few instances of this kind ; they are much more frequently found amongst the permanent teeth, and especially in the upper jaw. Their shape in general resembles the *Cuspidati*. He further observes, “ They are not confined to the front of the mouth. I have found them in every part of the jaw, between the middle *Incisores*, between the middle and lateral, between the lateral and *Cuspidati*, &c. among the large Grinders, on the outside or inside of them, and in the palate. I have also ten or twelve times found teeth beyond the *dentes sapientiæ* su-

* Nat. Hist. explanat. of Tab. viii. Fig. 9.

“ *periores*.

“ *periores*. They were all small, the enamel-
 “ led part shaped like the adult Grinders, but
 “ never with more than one fang. I call them
 “ *second wisdom teeth*, and always compliment
 “ my patient on the probability of possessing a
 “ double portion of sagacity.”

How supernumerary teeth are formed we can easily conceive, but how teeth could be inverted as Albinus and Mr. Hunter have shewn, is much more difficult to be accounted for. I have sometimes observed a supernumerary tooth, firmly attached to a Grinder; Fauchard has noticed similar appearances and also mentions his having met with two Grinders joined together, and a supernumerary tooth likewise connected with them*. However I do not think it necessary to dwell on this subject, particularly as it is a subject of curiosity more than of importance.

* Tom. 11. Planche 27. Fig. 16.

CHAPTER X.

Of the Vessels and Nerves of the Teeth.

HAVING repeatedly injected and examined the jaws of young subjects, I observed blood vessels passing from the gum to the membranes destined to form the cortex striatus.— It was natural enough then to conclude, that, as the investing membranes were derived from the gum, their nourishment too did originate from the same source, and that the use of the vessels which entered the proper *foramina* of the jaws, was only to form the pulp and bony part of the tooth. Further consideration of the subject however urged me to relinquish this opinion: it would by no means hold good on comparing it with what takes place in the jaws of large animals, for (as mentioned in chapter eight, page 83) the cortex striatus continues to be formed on the external plates of their teeth even after the upper part of them has appeared through the gum.

As frequent opportunity occurred in the course of this essay to mention the vessels and nerves of the teeth, I would not have allotted them a distinct chapter, were it not that Mr. Hunter asserts that the teeth are nearly inorganic, and also that “ we can actually transplant a tooth from one person to another *.” Although transplanting teeth was for some time practised, yet the dreadful consequences which so frequently ensued, as well as the bad success which commonly attended this operation, induced its most strenuous advocates (I trust for ever) to lay it aside.

Mr. Hunter in support of his doctrine asserts “ He could never trace the nerves distinctly even to the beginning of the cavity †.” Yet Eustachius seems to have been much more fortunate in his dissections of man as well as other animals, which appears from the following quotation : “ When we pass from the

* Nat. hist. page 38 and 126. See also part 2d. page 94. 95, &c.

† Nat. hist. page 42.

“ Grinders to the small teeth, the nerve with
 “ its concomitant artery is divided into two
 “ branches, one of which passes out through
 “ the hole in the jaw near the lower lip; the
 “ other branch proceeds on to the roots of
 “ the Incisores and sends to each a twig, one
 “ portion of which is expanded on the exter-
 “ nal membrane of the root, but the other
 “ and that the most delicate passes into the
 “ internal cavity. This fact indeed can be
 “ easily observed even in the human body by
 “ those who are engaged in accurate dissec-
 “ tions. But it is truly wonderful and seems
 “ almost inconsistent with the laws of nature,
 “ that the Incisores and Canine teeth, which
 “ are small and have only one root, possess
 “ large and conspicuous branches of nerves
 “ and vessels, whilst the Grinders, which are
 “ much larger and have three and sometimes
 “ four roots, are supplied by branches proceed-
 “ ing to each root nearly as small as hairs *.”

I 2

Doctor

* “ Postquam vero a molaribus ad minores dentes
 “ descensum est, nervus cum arteria, quæ illum comi-
 “ tatur, bipartito scinditur, cujus pars una per foramen
 “ eo loco sculptum, ad labium inferius emergit; altera
 “ ad

Doctor Monro has several preparations in his Museum, in which the nerves and vessels were traced by him into the roots of the teeth, and also into the pulp, which appears sufficiently evident in Tab. i. Fig. 4. g. &c. *

Mr. Hunter observes, “ A strong circumstance in support of the teeth having no circulation in them, is that they never change

“ ad radices Incisorum tendit, distributoque cuique
 “ ipforum furculo, una portione sui cum exteriori radi-
 “ cum parte jungitur ; altera autem, eaque tenuissima,
 “ finum dentium penetrat ; quod quidem etiam in ho-
 “ mine ab his qui sectionem docte et accurate tractant,
 “ cerni non difficulter potest. Sed mirum profecto est,
 “ et naturæ æquitati parum decens videtur, Incisores
 “ et Caninos dentes, parvos, unaque radice infixos,
 “ ejusmodi nervorum ac vasorum furculos magnos et
 “ conspicuos obtinere, patentique via ad insertionem
 “ accedere : Molares vero, eis longe majores, tribusque
 “ et interdum etiam quatuor radicibus præditos, eosdem
 “ furculos, qui bifariam, trifariamve, ac etiam quadri-
 “ fariam scindi debent, capillorum modo tenues habere,
 “ obscurissimoque itinere incedere.” Opuscul. de
 dentib. page 63.

* Nat. hist. page 39.

“ change by age, and seem never to undergo
 “ any alteration, when completely formed,
 “ but by abrasion ; they do not grow softer,
 “ like the other bones, as we find in some
 “ cases, where the whole earthy matter of the
 “ bones has been taken into the constitution.
 “ From the foregoing experiments it would
 “ seem that the teeth are without absorbents
 “ as well as other vessels, and are to be confi-
 “ dered as extraneous bodies, with respect to
 “ a circulation through their substance.”—

These remarks of Mr. Hunter's are by no means just, for the bony part of a tooth undergoes changes by age, as well as any other part of the body. Indeed if by chance the vessels which enter the roots and are distributed on the pulp be torn, or destroyed, the body of the tooth becomes discoloured, sometimes nearly black, the external membrane which surrounds the roots not being sufficient to supply it with nourishment, so that the bony part acts as a foil to the cortex striatus. I have frequently observed their roots changed nearly to a cartilaginous substance and rendered perfectly transparent by the absorption
 of

of the bony matter. The roots of the Grinders have been so frequently observed joined together by exostosis, that its occurrence was well known to Eustachius, nay even to Hippocrates *. However an incontestable proof of the presence of vessels both circulatory and absorbent and consequently of nerves, may be deduced from the progressive or continued growth of the Incisores in the squirrel tribe, and the colouring of the teeth of all animals from feeding on food mixed with madder, and the subsequent loss of the acquired colour from discontinuing the use of madder : this circumstance shall be referred to in the next Chapter.

In one of my preparations I observed that the artery and nerve separated, soon after their entrance into the common foramen of the jaw, the artery passing in a distinct groove near the roots of the teeth, and sending off a small branch in the course of the nerve to nourish it, so that in this case they could not impede each others action †.

* Opuscul. De Dentib. page 97. † Tab. i. Fig. 7.

CHAPTER XI.

Of the Cortex Striatus.

I HAVE frequently demonstrated in the course of this essay, that (in all the animals we have been examining, as well as man) the earthy matter of the *cortex striatus* was at first deposited by the investing membrane, in a soft and moist state, on the external bony lamella of a tooth. In this condition, when allowed to dry on the human tooth, it cracks, it assumes a yellowish white colour, adheres to the tongue, feels rough and stains the fingers slightly when rubbed between them. It continues seemingly without any change of texture until it has acquired its full degree of thickness, when the vessels of the investing membrane assume a different mode of action, from what they had hitherto done and probably pour out a fluid, which disposes the earthy particles to arrange in such order, as by virtue of their mutual attraction to form themselves
into

into fibres of an angular shape, from whose apposition arises a mass of a determinate figure, the surface of which becomes white, shining, hard and beautifully polished.

On breaking a perfect tooth, we observe the cortex striatus composed of innumerable fibres, disposed upon the bony part of the tooth in the same manner as those of the articular cartilages over the extremity of the bone in the joint of the thigh, or any of the other very moveable joints ; or they are crystallised exactly in a similar manner to the striated snow white zinc spar of Mr. Kirwan *. These fibres are first formed or crystallised on the points or edges of the tooth, and they proceed very slowly range after range towards the neck where they terminate.

The accuracy of Mr. De la Hire's observations, respecting the arrangement of the fibres of the cortex striatus upon the body of the

* Tab. iv. Fig. 20. 21. &c. See also Kirwan's mineralogy. Vol. II. page 236.

tooth,

tooth, justifies their insertion. He says, “ It
 “ is composed of numberless small fibres,
 “ which are attached to the internal part of
 “ the tooth by their roots, nearly as the nails
 “ and horns are to the parts with which they
 “ are connected. We can see without diffi-
 “ culty this structure when a tooth is broken,
 “ and we observe that the fibres which arise
 “ from that part of the tooth next the gum,
 “ are there very much inclined, but they are
 “ placed perpendicular on its base ; by which
 “ means they resist in a greater degree with-
 “ out injury the actions to which they are ex-
 “ posed *.

* “ Qu'elle est composée d'une infinité de petits filets,
 “ qui sont attachez sur la partie interne de la dent par
 “ leurs racines, à peu près come les ongles et les
 “ cornes le sont aux parties où elles s'attachent. On
 “ voit très facilement, cette composition dans une dent
 “ rompuë, où l'on remarque que tous ces filets, qui
 “ prennent leur origine vers la partie de la dent qui
 “ touche la gencive, sont fort inclinez à cette partie, et
 “ presque perpendiculaires sur la base de la dent : par
 “ ce moyen ces filets résistent davantage à l'effort qu'ils
 “ sont obligez de faire en cet endroit.” Mathém. et
 memb. de l'Acad. Roy. des Sciences. Mém. de
 l'Acad. de 1699.

Many

Many authors suppose that after the tooth has appeared through the gum, the cortex striatus continues to increase in thickness and hardness, and that it becomes more and more perfect and beautiful until a certain period of life, at which period *only* it begins to wear away. Fauchard says, “ This substance which we call
 “ the enamel, is formed previous to the ap-
 “ pearance of the tooth, but it strengthens and
 “ becomes more beautiful, until the age of
 “ twenty years or thereabout ; after which
 “ period it begins to wear away by the con-
 “ tinual friction *.” The many observations however already made on the cortex striatus, and also those which are immediately to follow, will induce us to form a very different opinion from Fauchard and others.

I have shewn in chapter iv. page 35, that Mr. Hunter's theory respecting the formation

* “ Cette substance que l'on nomme émail, se forme
 “ avant la sortie de la dent, se fortifie et s'embellit
 “ jusqu' à l'âge d'environ vingt ans ; après lequel tems
 “ cet émail commence à s'user par le frottement conti-
 “ nuel.” Le Chirurgien dentiste, Tom. i. pag. 24.

of

of the cortex striatus is not just, for he supposed that it was formed both by a pulp and capsula. Now the cortex striatus according to my observations is deposited and formed by a membrane alone, and I have repeatedly mentioned that when it assumed the crystalline form the membrane was wasted. It has been also demonstrated in the human tooth, as well as in those of animals, that, even where the investing membrane was not wasted, the cortex striatus once formed did not receive the slightest accretion of a similar substance, but that the membrane assumed a different mode of action and deposited a crusta petrosa on its surface, as is so generally observed in graminivorous animals *. From thence and many other observations and experiments, I conclude, that, when once a tooth penetrates the gum, the cortex striatus is then as hard and perfect on it, as it can be at any future period of life, nor does it even after that period receive the slightest degree of nutrition ; indeed it does not seem to require it, for I have frequently ob-

* Tab. iii. Fig. 7 and 8. b. b.

served

served in old church yards the cortex striatus quite perfect, although the bony part had entirely mouldered to dust. The appearance of the cortex striatus however is much influenced by the state of the bony part underneath, the colour of which in a certain degree it partakes of, so that it seems to improve until a certain period of life, though in reality it does not; and as I just now mentioned it does not increase either in thickness or hardness, after it has appeared through the gum.

The cortex striatus is perfectly formed, in a much shorter space of time, on some teeth than on others; the slow progress of it however does not seem to have much influence with respect to its perfection, for, it is frequently observed more perfect and beautiful on those teeth which require only twelve or fourteen months for their formation, than on those which require as many years, scil. the temporary Incisores and wisdom teeth. In general it seems to require about six or eight years, from the time it commences to crystal-
 life on the points of the permanent teeth,
 until

until it is perfectly formed around their bodies.

From the foregoing observations we can readily understand, how defects, or derangements in the constitution, or the many changes which take place in it, during the periods we have mentioned, may at times totally impede the formation of the cortex striatus, or render it susceptible of various stages or degrees of perfection. Now as the corresponding teeth in both jaws (for example the anterior permanent Grinders) are formed at the same time, if there should have been any derangement in the system during the period of their formation, we find their cortex striatus imperfectly formed and of course the foundation of their decay laid. But as a considerable period elapses between their formation and that of the middle Grinders, the constitution often acquires such vigour in this interval, that the middle ones are frequently observed perfect, whilst the anterior are rotten,

I have

I have many times met with teeth on whose points or edges the cortex straitus was perfectly formed, but immediately under the perfect fibres, it became imperfectly crystallised, of a yellowish colour and remarkably indented or pitted. These pits frequently extend over a great portion of the body of the tooth and the cortex striatus becomes again perfect towards the neck ; they are usually situated on the upper surface and sides of a Grinder particularly at the junction of the shells *.

There is a permanent Incisor amongst my preparations, the upper part of the cortex striatus on the body of which was imperfectly formed, being soft, pitted, and of a dark brown colour ; a few perfect fibres however were formed near the neck, and instead of the pulp contracting at this part as it usually does, it extended considerably beyond the body of it, as if nature endeavoured at this period to form it anew †.

* Tab. iv. Fig. 6. a. and Fig. 30. a. a.

† Tab. iii. Fig. 10. a. b. c.

An ingenious Surgeon Dentist of Liverpool (Mr. Wooffendale) in endeavouring to account for these pits, makes use of the following observations *. “ I have been at some
 “ pains, and I believe my endeavours have
 “ not been in vain, to ascertain a cause for
 “ these appearances,” which he entirely attributes to the small pox, but when his theory begins to fail he says “ I have frequently seen
 “ these marks on both the first and second sets
 “ of teeth, which causes me to suspect such
 “ children have had the small pox twice.”

In most of the cases I have just now mentioned, there seems to have been some defect in the constitution, with respect to depositing the ossific matter at certain periods ; but in other cases and those which are by far the most frequent, there seems to have been a want of that particular change which disposes the earthy particles to crystallise. Many times have I seen the anterior permanent

* Observations on the teeth, page 34 and 35.

Grinders as soon as they appeared through the gum, with almost the entire earthy matter of their cortex striatus perfectly soft and opake, most commonly however it remains soft at the interstices or junction of their shells, and at the termination of the cortex striatus on the neck of the tooth. I have also frequently observed a thin hard scale of the cortex striatus on the surface of a Grinder, which being broken by some accident, the internal part of it appeared quite soft; similar appearances (though less frequent) I have observed on all the teeth. But in the different tribes of animals we have been examining, some of whose teeth are formed in a much shorter space of time than the human, I have not as yet seen a single instance where the cortex striatus was imperfectly formed.

Although a variety of experiments have been made on young animals, in which their bones were deeply tinged of a red colour, by mixing madder with their food, I do not think any of them as yet prove, that the colouring matter was equally communicated to the cortex

tex striatus. Mr. Hunter says *, “ In all
 “ these experiments I never could observe,
 “ that the enamel was in the least tinged, ei-
 “ ther in the growing or formed tooth.—
 “ This looks as if the enamel were the earth
 “ more fully depurated or strained off from
 “ the common juices in such a manner, as not
 “ to allow the gross particles of madder
 “ to pass.”

Other Physiologists however assert the very
 reverse ; and I have frequently seen teeth the
 cortex striatus of which was said to be highly
 tinged by the animal feeding on food mixed
 with madder, but on carefully examining
 them, I found, that the external surface only
 was highly stained by grinding the food, for,
 when broken across, the internal part of the
 cortex striatus was scarcely tinged, and also
 the external colour was easily washed off.—
 I have however a very beautiful specimen of
 the Grinder of a young pig which had not
 appeared through the gum, the bony part of
 which is tinged of a most brilliant red colour,

* Nat. Hist. page 35.

but the cortex striatus although tinged is but slightly so in comparison with the bony part.

Mr. Hunter's experiments and observations on this subject, I have now shown are not just, particularly where he says " the enamel takes no tinge from feeding with madder, even in the youngest animals."

To ascertain whether the cortex striatus would take as deep a tinge as the bony part, I instituted the following experiment, which did not altogether answer my expectation ; however it establishes one fact, viz. " that the colouring matter of madder can be communicated to the *fœtus in utero*." I procured a female rabbit three or four days after pregnancy, and fed her regularly on food mixed with madder ; about twenty-eight days after she brought forth six young ones ; one of these I immediately deprived of life, and found its bones slightly tinged of a red colour. Another of them being suckled by the mother
for

for about twenty days, was then deprived of life, its bones were much more deeply tinged than the bones of the first. The bones of a third being fed on the food mixed with madder, for ten or twelve days after, were much more brilliantly tinged than any of the former. The teeth of all these animals were tinged, but whether the cortex striatus was equally stained with the bone, or whether the colour of the bone shone through the cortex striatus (which in the rabbit is remarkably thin) I cannot positively affirm.

At present however I am conducting a similar experiment on a pig, in order to ascertain this point, as well as many others : the cortex striatus being much thicker on this animal's teeth than on the former, and also being much more easily fed : the *progress of which* I intend to make public.

Doctor Rutherford in his lectures on Botany when speaking of madder, introduced some beautiful and interesting experiments he had

made on this subject, extracts from which he was kind enough to allow me to insert.—He says, “ It has been long known that if
 “ madder be mixed with the food of living
 “ animals, their bones presently acquire a red
 “ colour. This was accidentally first disco-
 “ vered in some hogs which had been fed in
 “ a dyer’s yard upon bran that had previ-
 “ ously been employed to discharge the loose
 “ and superfluous colouring matter from cal-
 “ lico or cotton cloth recently dyed with mad-
 “ der.

“ In these the bones were quite of a full
 “ red, while the cartilages and the meat, fat ;
 “ in general all the soft parts had no particu-
 “ lar tinge, or remained entirely of the usual
 “ appearance. A fact so unexpected imme-
 “ diately attracted the attention of the ob-
 “ server Mr. Belchier : and many experiments
 “ were made by him and by M. Du Hamel,
 “ to investigate the subject. It soon appear-
 “ ed, that only the proper bony part received
 “ the tinge,—the soft parts, even the gelati-
 “ nous and cartilaginous matters, in which
 “ the

“ the bones themselves were formed, remain-
 “ ing untinged, when the proper bony fibres
 “ had already acquired a deep red colour.—
 “ That the younger the animal was, the more
 “ quickly was the change produced : in a
 “ young pigeon some change was observed
 “ within twenty-four hours, and within three
 “ days all the bones were of a scarlet colour.
 “ That the bones were unequally tinged, the
 “ harder the more deeply, the middle there-
 “ fore of the long bones, and the bony part
 “ of the teeth (although the enamel remained
 “ quite white) the most deeply of all. Some-
 “ times however irregularly even in young
 “ animals, spots appearing in them much
 “ deeper than the general tint of the whole,
 “ in old animals, again several faint spots
 “ often appeared on a darker ground : or even
 “ spots of different colours or hues,—that
 “ by discontinuing the use of the madder, the
 “ red colour gradually disappeared or was
 “ discharged and the bones re-assumed their
 “ natural appearance.

“ Subsequent

“ Subsequent experiments have shewn that
 “ the fluids are also tinged by madder, the
 “ serum and milk especially. M. Du Hamel
 “ immediately concluded that it was the nu-
 “ tritious matter of the bone, only, which
 “ conveyed the colouring matter; and others,
 “ following his idea, have justly observed,
 “ that this is deposited along with the earth
 “ of the bone. But how this comes to pass,
 “ why the bones receive a much deeper tinge,
 “ than any other parts of the body, has not,
 “ so far as I know, as yet been satisfactorily
 “ explained. Though M. Du Hamel ap-
 “ proached nearly the true explanation,
 “ when he illustrated the subject by the phœ-
 “ nomena observed in dyeing cloth with
 “ madder.

“ We have in the fact before us, a beauti-
 “ ful example of a particular case of chemical
 “ attraction; such as, in numberless instances,
 “ is observed to take place betwixt the colour-
 “ ing particles of both animal and vegetable
 “ substances and various other bodies; espe-
 “ cially earths or earthy salts, and oxydes of
 “ metals.

“ metals. So strong is the affinity of the co-
 “ louring matter to these bodies, that it is fre-
 “ quently observed to quit the menstruum in
 “ which it may chance to be dissolved, to
 “ unite with them ; they, in consequence of
 “ its union, acquiring a particular tinge, while
 “ the menstruum is proportionally deprived
 “ of colour. Or, when both happen to be
 “ dissolved in the same menstruum, if, by any
 “ means, these bodies are disengaged, become
 “ insoluble in the menstruum, and are precipi-
 “ tated from it, the colouring matter likewise
 “ falls down along with them, or in combina-
 “ tion with them. From this principle, this
 “ mutual attraction, is deduced the various
 “ use of these bodies, as mordents, as they are
 “ called, intermedia, or means for fixing the
 “ colours in dyeing, and staining thread, or
 “ cloth, whether it be composed of animal or
 “ vegetable materials.

“ It is often to be observed that the colour-
 “ ing matters, which are commonly employ-
 “ ed as dye stuffs, have hardly any conspicu-
 “ ous affinity with pure animal or vegetable
 “ fibres,

“ fibres, and that, though they seem to com-
 “ municate a considerable tinge to these fibres,
 “ yet the colour adheres only slightly to their
 “ surface, so that it can easily be washed or
 “ rubbed off again, thus leaving these fibres
 “ very nearly of their original complexion.
 “ But if the fibres be previously impregnated
 “ with a proper mordent, by the interposition
 “ of this, and in consequence of the mutual
 “ affinity that subsists, both betwixt it and
 “ the colouring matters, and likewise betwixt
 “ it and the fibres, the colouring matter now
 “ attaches itself so strongly to these fibres, that
 “ they seem to become incorporated altoge-
 “ ther, and the colour communicated to the
 “ fibres is proportionally fixed and durable ;
 “ and resists, unchanged, the action of vari-
 “ ous substances, by the application of which,
 “ it would have been otherwise greatly alter-
 “ ed, or perhaps entirely discharged.

“ Upon the same principle depends the
 “ preparation of those pigments, known to
 “ painters by the name of Lakes. These are
 “ truly precipitates of the colouring matter, in
 “ combination

“ combination with various mordents as their
 “ bases. They are prepared by mixing to-
 “ gether solutions of the mordent and colour-
 “ ing material : or dissolving both in the same
 “ menstruum, and adding, if need be, such
 “ substances as shall effectuate their precipita-
 “ tion, or cause their separation from the
 “ menstruum. The colour of the lake may
 “ frequently be changed at pleasure even while
 “ the same colouring material is employed,
 “ viz. by using different mordents, as the co-
 “ lour is influenced by the nature of the par-
 “ ticular mordent that is used, and the peculiar
 “ chemical action this may have upon the
 “ colouring matter.

“ The colouring of the bones of a living
 “ animal, by the use of madder, is in every
 “ circumstance analogous to the preparation
 “ of these lakes. The colouring matter of
 “ the madder, passing unaltered through the
 “ digestive organs of the animal, enters the
 “ general mass of fluids, and is dissolved in
 “ the serum of the blood ; to which, indeed,
 “ if it be in large proportion, it communicates
 “ a very

“ a very sensibly red tinge. But there is al-
 “ ways present in the blood, and in a state of
 “ solution in the serum, a quantity of the
 “ earthy matter of the bones, phosphate
 “ of lime, ready to be deposited, as the
 “ exigencies of the animal shall require.
 “ Now, the phosphate of lime is an excellent
 “ mordent to madder, has a strong affinity to
 “ it, and consequently is admirably fitted to af-
 “ ford a base to the colouring matter of it, and
 “ thus forms a lake. This is what actually
 “ takes place, whenever, in such circum-
 “ stances, by a peculiar animal process, the
 “ matter (which probably serves to keep the
 “ phosphate in solution) being withdrawn,
 “ this concretes within the cellular texture,
 “ into the fibrous and solid matter of the
 “ bones : for at the instant of its losing its
 “ solubility, it powerfully attracts and com-
 “ bines with the colouring matter of the mad-
 “ der, that is present in the serum, communi-
 “ cating insolubility also to this colouring
 “ matter and hence they both concrete toge-
 “ ther into a homogeneous mass, not white
 “ or colourless, as the pure earth of bones
 “ usually

“ usually is, but tinged of a full crimson or
 “ carmine colour.

“ That this is actually the case may be
 “ shewn by various experiments. Thus, if
 “ to an infusion of madder, in distilled water,
 “ be added a little of the muriate of lime, no
 “ change is perceived ; but if to this mixture
 “ be added a solution of the phosphate of soda,
 “ immediately a double elective attraction
 “ takes place : The muriatic acid, combining
 “ with the soda, remains suspended or dissolv-
 “ ed in the water ; while the phosphoric acid,
 “ thus deprived of its soda, combines with the
 “ lime, which the muriatic acid had parted
 “ with, and forms phosphate of lime, or earth
 “ of bones. This substance being, however,
 “ insoluble in water, falls to the bottom : but
 “ having combined, at the instant of its for-
 “ mation, with the colouring matter of the
 “ madder, they fall down united into a crim-
 “ son lake, precisely of the same tint with that
 “ of bones, of young animals, which have
 “ been fed with madder.

“ From

“ From this simple representation of the
 “ matter, we have a ready explication of eve-
 “ ry circumstance that has been remarked as
 “ extraordinary respecting this subject.

“ Why *e. g.* the bones of young animals
 “ should be more quickly, and more deeply
 “ tinged than the bones of older animals.—
 “ Because there is a more rapid deposition and
 “ also more rapid change of earthy matter in
 “ the bones of young animals—though pro-
 “ bably the earthy matter as it is deposited,
 “ is equally deeply tinged in old as in young
 “ animals, yet, in the latter, the colour of it is
 “ less diluted by the intermixture of particles,
 “ which had concreted before the commence-
 “ ment of the experiment, and were conse-
 “ quently of the natural or white colour.—
 “ Why the harder parts of the bones are most
 “ deeply tinged—because a greater number
 “ of coloured particles are compacted into the
 “ same space.—Why sometimes a bone seems
 “ mottled or spotted—because, there had, pro-
 “ bably, been some topical irregularity, res-
 “ pecting either the secretion of fresh bony
 “ matter,

“ matter, or absorption of what had formerly
 “ been deposited.—Why the bones acquire a
 “ very deep tinge, when perhaps the serum
 “ of the blood has not acquired any sensible
 “ colour from the madder—Because the
 “ fluids being in constant motion and the
 “ earthy matter being deposited very slowly
 “ the nascent bone being continually washed
 “ and for a considerable length of time by the
 “ stream of serum, it attracts and combines
 “ with the colouring matter of all the serum,
 “ with which it chances to be washed, while
 “ it is in the act of concretion. Hence like-
 “ wise appears, why the gelatinous and soft
 “ matters in which the bone itself forms should
 “ have no tinge, though the bony fibres ac-
 “ quire a very deep one; for even were these
 “ matters composed chiefly of the matter of
 “ bone, still this must be in a state of solution
 “ and in that state it cannot attract or cause
 “ any accumulation of the colouring matter
 “ or separation from the fluid in which it is
 “ dissolved.—Why the enamel of the teeth
 “ receives no colour—because in fact there is
 “ no change in that substance, with respect
 “ to

“ to either secretion or absorption after it is
 “ once formed.

“ But it by no means follows, that the ena-
 “ mel of the teeth may not acquire a tinge, in
 “ the same manner as the earth of bones, pro-
 “ vided that the fluids of the body were suffi-
 “ ciently loaded with the colouring matter of
 “ madder, or other such tinging material, at
 “ the time that the enamel is secreted, or first
 “ assumes a concrete form ; as in young ani-
 “ mals while their teeth are just in a nascent
 “ or incipient state ; or perhaps still better, in
 “ the foetus in utero, viz. by mixing the ting-
 “ ing materials plentifully with the food of the
 “ mother during her gestation.

“ But even though the enamel should ac-
 “ quire a tinge in such trials ; it may well be,
 “ that this tinge shall be very different from
 “ that acquired at the same time by the bones :
 “ For as the structure and composition of the
 “ enamel is different from those of the fibrous
 “ or earthy part of the bones, it is likely that it
 “ may have a different effect in modifying the
 “ colouring

“ colouring matter of madder ; both with ref-
 “ pect to the particular tint or species of co-
 “ lour, and the particular shade or intensity of
 “ it : Just as we find, that with the same co-
 “ loured infusion, by employing different
 “ mordents or bales, various lakes may be ob-
 “ tained differing from one another in colour,
 “ both in species and degree.

“ The same observations may be made
 “ concerning the concreting particles of many
 “ other solids of the body. Those of the
 “ different solids may receive at the same
 “ time, each, according to its particular nature,
 “ a different hue. Or perhaps having no par-
 “ ticular affinity with the colouring matter of
 “ madder, incapable therefore of acting as a
 “ mordent to it, may receive not the slightest
 “ tinge from it. It is to be understood that the
 “ solids here alluded to are those only which
 “ derive the firmness of their texture from the
 “ chemical concretion of particles deposited in
 “ them from the general mass of fluids. These
 “ particles must therefore be considered as ab-
 “ solutely lifeless and inert, possessed of no qua-
 “ lities

“ lities whatever but such as are competent to
 “ any inanimate matter. It is with these
 “ particles only that the colouring matter
 “ combines. These then are the only parts of
 “ an animal body which can be tinged or co-
 “ loured by the use of madder or any other
 “ such material. Hence it is not to be ex-
 “ pected, that the living solids of the body,
 “ *e. g.* the brain or nerves, should ever receive
 “ the slightest tinge in such experiments, or
 “ even those that are formed by the coagula-
 “ tion of the coagulable parts contained in
 “ the fluids of the body.

“ It is natural to suppose, that there may be
 “ many vegetable substances, which like the
 “ roots of madder, are possessed of the quality
 “ of communicating a particular colour to the
 “ bones of living animals : all that is required
 “ for producing this effect, is, that the colour-
 “ ing matter of these substances should be of
 “ such a nature, that it shall not be altered by
 “ the digestive powers of the stomach, shall
 “ enter the mass of fluids and be dissoluble in
 “ the serum of the blood, and that it shall
 “ have

“ have a strong chemical affinity with the
 “ earth of bones. Then we may reasonably
 “ conclude, that by the use of such substance,
 “ the bones will acquire the particular colour
 “ the substance employed usually gives to
 “ other bodies, and we attain to almost abso-
 “ lute certainty in this matter, by such an ex-
 “ periment as that formerly taken notice of.—
 “ Several such substances have already been
 “ discovered and their power ascertained, by
 “ direct experiments upon living animals *e. g.*
 “ the roots of several species of the *galium*,
 “ *asperula* and other plants of the same natural
 “ order with the *rubia*, all those like the *ru-*
 “ *bia* itself, give a red colour to the bones.—
 “ But there are probably, many others, hi-
 “ therto unascertained which would give very
 “ different colours : or at least very different
 “ tints of red. Many plants are known to
 “ give a red colour to the urine, *e. g.* Beet
 “ root, fruit of the *opuntia* or Indian fig;
 “ many more communicate a yellow tinge to
 “ the urine, and sometimes a tinge of great
 “ brilliancy. A single dose of the root of
 “ rhubarb will frequently render the urine

“ of a gold colour. There can be little
 “ doubt that by the continued use of such
 “ plants, the bones would also acquire a bright
 “ yellow colour. Perhaps some plants may
 “ be found abounding with a blue juice, of
 “ such chemical qualities, as to enable it to
 “ tinge the bones of living animals of a blue
 “ colour : an example indeed does not occur
 “ of one exactly fitted for this purpose, ex-
 “ cept perhaps the *genipa americana*, the
 “ pulp surrounding the seeds of which, is said
 “ to stain animal matters of an indelible blue :
 “ and this might perhaps resist the digestive
 “ processes going on in the stomach, and in
 “ this case would probably give a blue colour
 “ to the bones. The juices or rhinds of
 “ some other purple fruits may be possessed
 “ of such qualities, as several appear to pass
 “ through the intestinal canal without having
 “ undergone a very great change in respect
 “ of their colour.”

I mentioned in my thesis (page 126) that
 the cortex striatus differed materially in its
 chemical qualities from the bony part of a
 tooth,

tooth, being chiefly the carbonate of lime, but did not introduce the few experiments I had an opportunity of making on it, thinking them by no means conclusive: I shall now however mention those which induced me to form this opinion. Experiment 1. I found that the cortex striatus was entirely soluble with effervescence in dilute nitric or muriatic acids. Ex. 2. When some of it was exposed to a heat of about 20 of Wedgewood for 25 minutes, it was reduced to a remarkably white powder; on throwing part of this into distilled water a hissing noise was heard, and on adding a few drops of muriatic acid to it, a much slighter effervescence took place, than where the fresh cortex striatus had been made use of. This subject, however, has been since prosecuted with much greater judgment and accuracy by the truly scientific analyst Mr. Charles Hatchett, and he was so very obliging as to repeat before me the experiments he had made on it, which were published in the Philosophical Transactions for the year 1799 *.

* See Mr. Home's Observations, &c. Page 9 and 10.

By these I was at once convinced of the error I had fallen into, for although the cortex striatus contains a certain proportion of the carbonate of lime, it is chiefly composed of the phosphate; the precise proportions however have not been as yet ascertained, Mr. Hatchett's time not permitting him to make a complete analysis, his experiments are as follows: Experiment 1. " Some enamel, rasped
 " into a fine powder, was put into a matrafs,
 " and, pure muriatic acid being added, the
 " whole was suffered to remain without the
 " application of heat during one hour; in the
 " course of this time, the enamel was com-
 " pletely dissolved with a gentle efferves-
 " cence.

" To this solution, some sulphuric acid was
 " gradually added, till all precipitation had
 " ceased: The precipitate was separated by
 " a filter, and was found to be selenite. The
 " filtrated liquor, by evaporation, afforded a
 " small additional quantity of selenite, which
 " was also separated; after which, the liquor
 " being evaporated became thick and viscid.
 " This

“ This, when diluted with water, precipitated
“ lime from lime water, in the state of phos-
“ phate.

“ To another portion, solution of acetite of
“ lead was added, and caused an immediate
“ precipitation of a white matter, which when
“ dried and sprinkled on burning charcoal,
“ produced a light and smell like phospho-
“ rus ; it moreover, was soluble in nitrous
“ acid and was thus to be distinguished from
“ muriate or sulphate of lead.

Experiment 2. “ Some of the raspings of
“ enamel were dissolved by digestion in nitric
“ acid, and, when the solution had been di-
“ luted and filtrated, it was saturated with
“ carbonate of ammoniac. The precipitate
“ thus produced was collected andedulcorat-
“ ed in a filter. The small excess of carbo-
“ nate of ammoniac, in the filtrated liquor,
“ was saturated with acetic acid ; after
“ which, the phosphoric acid was precipitated,
“ by solution of acetite of lead. Upon ex-
“ amining the first precipitate, or that produc-
“ ed

“ ed by the carbonate of ammoniac, it was
 “ found (contrary to expectation) that it was
 “ still composed of lime, combined with a
 “ portion of phosphoric acid, instead of car-
 “ bonic acid, which might have been sup-
 “ posed.

“ To effect, therefore, a complete separa-
 “ tion of the two ingredients, (lime and phos-
 “ phoric acid,) acetic acid was poured on
 “ the precipitate, by which it was immediate-
 “ ly dissolved. The whole of the phosphoric
 “ acid was then separated from this solution,
 “ by acetate of lead; after which, lest any
 “ lead should be present, the liquor was satu-
 “ rated with pure or caustic ammoniac, and
 “ the lead was separated by a filter: Lastly,
 “ the lime which remained dissolved, was
 “ precipitated (in the state of carbonate) by
 “ carbonate of ammoniac.

“ The enamel has been supposed, not a
 “ phosphate but a carbonate of lime. This
 “ error may have arisen from its solubility in
 “ acetic acid or distilled vinegar; but the
 “ effects

“ effects of the acetous acid are, in every res-
 “ pect, the same on powdered bone as on the
 “ enamel. Consequently, when enamel, or
 “ bone, is put into a glass matrafs containing
 “ acetous acid, placed in a sand bath, the por-
 “ tion which is dissolved, is not (as has been
 “ supposed) carbonate but phosphate of lime ;
 “ for, if to the filtrated solution nitrate or ace-
 “ tite of lead is added, a precipitate is produc-
 “ ed, of phosphate of lead, in the same man-
 “ ner as when nitrate or acetite of lead is add-
 “ ed to urine.”

Mr. Hatchett has made many other very
 interesting experiments and observations on
 shell and bone, &c. the results of which would
 be too numerous to insert, he however says
 that “ the enamel appears only to be different
 “ from tooth or bone, by being destitute of
 “ cartilage, and by being principally formed
 “ of phosphate of lime cemented by gluten.
 “ The difference, in the latter case, seems to
 “ explain why the bones and teeth of animals
 “ fed on madder become red, when, at the
 “ same time, the like colour is not commu-
 “ nicated

“ nicated to the enamel ; for it appears pro-
 “ bable, that the cartilages which form the
 “ original structure of the teeth and bones,
 “ become the channels by which the tinging
 “ principle is communicated and diffused *.”

Mr. Hatchett at this period had not seen Dr. Rutherford's experiments and observations on madder.

From the foregoing observations, it is perfectly evident, that the most simple and best prepared tooth powder, frequently applied to the teeth, must be injurious, as they all tend to wear away the cortex striatus. Even at present many people are not content with the use of tooth powder alone, but form it into a paste with syrup or honey, by which its action is much increased ; such preparations certainly clean the teeth much sooner than the others, they also much sooner wear off the cortex striatus and destroy its beautiful polish which never after can be regained.

* Mr. Hatchett's experiments, &c. page 19. Philosophical Transactions for 1799.

The tooth powders commonly sold consist in a great measure of cream of tartar, by the use of which I have seen the teeth completely deprived of their cortex striatus and the patients rendered quite miserable, for the bony part of the tooth in such cases becomes sensible to the slightest touch and also to the slightest change of temperature in the atmosphere or other fluids received into the mouth. Cream of tartar alone has been recommended by Mr. Hunter as a tooth power, because, as he says, “ at the same time that it acts mechanically, “ it has likewise a chemical power, and dissolves this adventitious matter*.”

To ascertain the bad effects of cream of tartar as a tooth powder, I made the following simple experiment, which will at once explain how very detrimental the use of it must be, even in the smallest proportion. I placed a tooth in a solution of cream of tartar and water, and allowed it to remain in it for about twelve hours, when taken out I observed that

* Nat. Hist. part II. page 69.

the surface of the cortex striatus was quite rough, and according as it became dry, it appeared sprinkled over with an immense number of small crystals though very few were observable on the root. The formation of these crystals can be easily accounted for : the acid of tartar has a greater affinity to calcareous earth than it has to the vegetable alkali with which it is combined in cream of tartar, a double elective attraction of course takes place when a tooth is immersed in a solution of it, the acid of tartar combines with the lime and forms a salt nearly insoluble in water and which is deposited in the form of crystals on the body of the tooth, whilst the other portions, scil. the vegetable alkali and phosphoric acid, &c. combine and remain dissolved in the mixture. Likewise in cream of tartar, the vegetable alkali is supersaturated with the acid of tartar, so that even in powder and without a complete decomposition of it, we see how readily it may act as a solvent for the cortex striatus, which is seemingly the chief part acted on by it, the bony part as already mentioned being covered with scarcely any of the crystals.

stals. When a tooth is placed in dilute acid of tartar, the body of it becomes covered in the same space of time with much larger crystals.

A variety of essences and lotions are also recommended and sold for cleaning the teeth, many of which contain acids, and though perhaps but a very small quantity, yet when constantly applied, they undoubtedly must dissolve and destroy the cortex striatus, &c. I shall terminate this chapter by seriously recommending parents to have their children's teeth and *gums* in particular brushed and washed with a soft brush and water at least morning and evening, commencing at the period when the temporary teeth are complete, that is, in general about the second year. This early attention will render the operation habitual, and I am fully convinced the benefits to be derived from it are almost incalculable.

If their teeth and gums are diseased, I need not add that medical assistance should be immediately procured, for I have met several
cases

cases, in which (by neglecting to keep the gums of children in good order) some of the permanent teeth have been cast off with the temporary ; one case in particular occurred to me of a child about three years old, in which the four permanent incisores of the under jaw and a considerable portion of the jaw itself had been sloughed off, by not attending to the child's mouth whilst it was labouring under and after the recovery of the confluent small pox ; this child of course will be disfigured through life.

CHAPTER XII.

Of Dentition.

THE human body, on account of the very great delicacy of its structure, is at all periods of life subjected to a variety of complaints ; but by reason of the extraordinary degree of irritability during infancy, the body is then peculiarly susceptible of morbid impressions, from even the slightest cause, especially during
the

the first year or two after birth. As some reason must be assigned for the various affections which then occur, and as most of the temporary teeth appear during this period, Empiricks (to screen their ignorance) have hit on that theory most likely of all others to be received by the mass of the people, viz. that these complaints were owing to the irritation, occasioned by the violent efforts the teeth make in bursting and tearing through the gums. This opinion has been handed down from one generation to another, and we find the ancient as well as most of the modern physicians contenting themselves with the old adage, that, “ what every one says must be true” without thinking for themselves, or accurately examining the appearances and state of the parts, which alone could be acquired by dissection.

It would be both tedious and uninteresting to the reader to collect and arrange the hypothetical remarks diffused through numberless volumes in order to support this doctrine ; a few of their observations will therefore be sufficient

ficient to show how discordant they are one with the other, and also the very fallacious inductions they deduced from them. Hippocrates supposed the most violent affections arose from the cutting of the canine teeth * : Boerhaave on the other hand supposed they arose from the appearance of all the sharp teeth, scil. the incisores † ; but his commentator Van Swieten differs with him and gives a most plausible reason why some teeth work their passage through the gum with much less difficulty than others. He says, “ As all the
 “ foregoing disorders proceed from the
 “ stretching, puncturing, and lacerating the
 “ nervous and bloody gums, it is evident
 “ therefore that the worst symptoms are to
 “ be dreaded when the canine teeth are burst-
 “ ing out, because they have an obtuse point
 “ and are pretty thick. The incisores howe-
 “ ver resemble a sharp wedge ; hence they
 “ more easily cut through the incumbent
 “ membrane than the former. But the mo-
 “ lars, although they have a broader surface

* Aphor. 25. Sect. 3. † Aphor. Sect. 1374.

“ than

“ than the canini and also have four points,
 “ are more easily borne by the child, because
 “ these points do not appear at one and the
 “ same time but successively *.” Fauchard
 although he has adopted the same opinion as
 Van Swieten respecting the incisores ; never-
 theless, comes nearer the truth when speaking
 of the molares ; he says, “ The incisores, being
 “ small and sharp, cut through the gums with
 “ less difficulty than the canini, and the child
 “ suffers much less by them. The molares
 “ however which are considerably larger and
 “ nearly square, pierce the gums with much
 “ greater violence than any of the others, but

* “ Cum autem omnia hæc mala a tensione, punc-
 “ turâ, laceratione, gingivarum nervosarum, sanguino-
 “ lentarumque, oriantur, patet facile, omnia hæc mala
 “ magis metuenda esse, dum erumpunt dentes canini,
 “ qui obtusum apicem habent, et satis crassi sunt. In-
 “ cisoires acutum referunt cuneum ; hinc facilius mem-
 “ branam incumbentem findunt. Molares autem, licet
 “ latiore superficiem habeant quam canini, et qua-
 “ tuor apices, facilius feruntur ; quoniam non simul
 “ et semel, sed successive, illi apices emergunt.” Com-
 “ ment. Vol. XIV. Pag. 746.

“ as

“ as they appear very slowly and the child
 “ gains strength and age, it can support with
 “ less danger the pain produced by them *.”
 Doctor Underwood differs from all these au-
 thors, for he says, “ It will be frequently ne-
 “ cessary to lance the gums several times, on
 “ account of the extraordinary difficulty with
 “ which some infants cut their teeth, especi-
 “ ally the double ones, which are furnished
 “ with two or more knobs or points. Fever,
 “ purging, and even convulsions, will some-
 “ times arise from only one point of a large
 “ tooth offending the *periosteum* that covers it ;
 “ and, being nearer the surface than the other
 “ points, the lancet sometimes does not com-
 “ pletely divide the membrane that lies over
 “ the rest ; and this part not being injured

* “ Les dents incisives étant plus petites et plus
 “ tranchantes, percent plus aisément que les canines,
 “ et font beaucoup moins souffrir l'enfant. Les mo-
 “ laires, qui sont bien plus grosses et presque carrées,
 “ percent les gencives avec plus de violence ; mais
 “ comme elles sont plus tardives, et que l'enfant a plus
 “ d'âge et de force, il supporte plus aisément la douleur.”
 Le Chirurgien dentiste, Vol. I. page 50.

“ by

“ by the tooth, the symptoms subside on
 “ having divided that portion of membrane
 “ that was inflamed. But, in a little time,
 “ another point of the same tooth is found to
 “ irritate the *periosteum*, and calls for the like
 “ assistance of the lancet, which again re-
 “ moves all the complaints *.” Thus we
 find all the temporary teeth accused (by one
 author or another) of producing (as they say)
 by their efforts to burst out, almost every
 symptom and complaint that has been menti-
 oned by Nosologists ; and each author in sup-
 port of his own doctrine attributing greater
 danger to the appearance of certain teeth than
 others, as well as the period of their appear-
 ance.

It cannot be doubted but that complaints
 which arise from very different sources, have
 been and are at present attributed to teething.
 The celebrated Sydenham tells us “ It is a
 “ common observation that infants are fre-
 “ quently thrown into fevers by the pains at-

* Diseases of Children, Vol. I. Pag. 217.

“ tending dentition, which are not easily
 “ distinguished from fevers of another kind.
 “ I have been long tormented with the treat-
 “ ment of those, nor ’til lately, could I be per-
 “ suaded that any of them that were entrust-
 “ ed to my care, were restored to health so
 “ much by art as accident, until having been
 “ frequently reminded of a remedy not very
 “ celebrated but rather disregarded for being
 “ in common use, I however ordered it and
 “ found it answer my utmost expectation, be-
 “ ing preferable to any medicine I had previ-
 “ ously tried. It is two, three, or four drops
 “ of spirits of hartshorn according to the age
 “ of the child, given in a spoon full of black
 “ cherry water or any other proper julap
 “ every fourth hour to the fourth or sixth
 “ time*.” I think it very probable Syden-

* “ Vulgo enim notissimum est infantes à doloribus
 “ ex dentitione ortis, sæpiùs in febres agi, quæ haud ita
 “ facilè ab alterius generis febribus internoscuntur.
 “ In harum ergo curatione diu multùmque angebar, nec
 “ nisi nuperis his annis certò mihi persuadere potui
 “ quemlibet

“ ham

ham fell into the very snare he wished us to avoid, for it is not likely that a fever occasioned by dentition, would yield so frequently, as he says, to a few drops of spirits of hartshorn, at least if such violent irritation is produced in the system as is so generally supposed: It appears however that this medicine has been in considerable use and repute, for Boerhaave tells us, that convulsions arising from dentition have been happily cured by a small dose of the volatile alkali *. Such convulsions I should think arose from some derangement

“ quemlibet ex illis qui meæ curæ concrediti ad sanitatem restituti fuerunt, tam arte quàm casu convaluisse, donec tandem de felici successu remedii haud ita celeberris, imo ad tritum ejus usum planè contempti, frequenter admonitus, illud ipse quoque præscribere rem; quod etiamnum præ cæteris quæ mihi innotescunt medicamentis optimè votis hic respondet. Ejusmodi verum est guttæ duæ, tres, vel quatuor *spiritus* cor. cerv. pro ratione ætatis, in cochleari uno vel altero aq. cerasor. nigr. vel julapii alterius appropriati exhibeantur quarta quaque horâ ad vices quatuor vel sex.” Opera Universa, pag. 504.

* Aphor. 1378.

either of the stomach or bowels and not from teething.

It is not my intention to point out the medical treatment of children during these periods, but concisely to mention in what manner (as far as I can judge) the appearance of the teeth might occasion violent and dangerous symptoms, and also how they may be avoided. It is likewise necessary to investigate the present mode of lancing the gums, an operation which has been in general use and recommended by the first authorities.

I designedly omitted, when treating of the commencement and formation of the permanent teeth, saying any thing particular respecting the change which then takes place in the sockets of the temporary; but reserved it for this place. Soon after the permanent sacs have commenced and that each sac becomes surrounded with a bony socket, there is a disposition in the plates of the alveolar processes to contract a little over the surfaces of the temporary teeth, and as Mr. Hunter justly remarks,

marks, “ The alveolar processes grow, and
 “ for some time keep the start of the teeth, and
 “ perhaps the reason why the mouths of the
 “ sockets have this tendency to contract, is in
 “ order to support the gums, and prevent
 “ them being injured before the teeth come
 “ through *.” The structure of the gum I
 likewise reserved : It seems a substance *sui*
generis, externally it is covered by the cuticle
 which lines the mouth and which can be rea-
 dily separated from it, immediately under the
 cuticle it appears composed of cellular mem-
 brane and a plexus or net work of vessels.
 The external *periosteum* of the jaw seems lost in
 it, and I could not afterwards by any means se-
 parate it into lamellæ. The gum seems a sub-
 stance (as I have had frequent occasion to
 mention) designed in a certain degree to form
 and afterwards to accompany and support the
 teeth through life, and in old age to become a
 callous covering to the jaws, deprived of teeth
 and alveolar processes. The gums in general
 are not possessed of much sensibility, but when

* Nat. Hist. page 75.

irritated

irritated even by slight causes, they are apt to inflame and become remarkably tender and painful, similar to the *tendinous aponeurosis* &c.

In all the examples we have been examining, I have shown that in proportion as the teeth rise, the upper parts of the sockets exposed to their pressure are absorbed; and I have repeatedly shown that as soon as the investing membrane had perfected the cortex striatus, it was wasted, the gum we have seen partakes of this tendency to waste or is absorbed and the teeth commonly pass with great ease through it and frequently without the knowledge of the mother or nurse. In some few cases however where nature does not preserve her regular mode of action, violent symptoms may arise: for instance if the root or roots advance more rapidly than the body of the tooth, the vessels of the gum and even those of the investing membrane may become inflamed. Such cases however I look on to be very rare, and I do not think, that this natural process in the animal œconomy, in which all animals (man excepted)

cepted) seem to suffer little or no inconvenience, should be accounted and ranked as a most fatal disease. Doctor Caddogan in his essay on nursing introduces the following valuable remarks, “ Breeding teeth has been thought
 “ to be and is fatal to many children ; but I
 “ am confident this is not from nature ; for it
 “ is no disease, or we could not be well in
 “ health till one or two and twenty, or later.
 “ Teeth are breeding the greatest part of that
 “ time ; and, it is my opinion, the last teeth
 “ give more pain than the first, as the bones
 “ and gums they are to pierce are grown more
 “ firm and hard.”

We shall now examine into the means of relief, which have been employed, and those also which may occasion the teeth to cut easily. Boerhaave says *, “ This may be
 “ effected, 1st. by softening, cooling, and
 “ assuaging the gums, with soft, glutinous

* “ Quod fit. 1. gingivas emolliendo, refrigerando,
 “ leniendo, mollibus, glutinosis, antiphlogisticis ; 2.
 “ sæpe atterendo ad corpora dura, glabra ; 3. disse-
 “ cando ope lanceolæ.” Aphor. 1377.

“ and

“ and antiphlogistic remedies. 2dly, By often
 “ rubbing them with hard, smooth bodies.
 “ 3dly, By cutting them with a lancet.”
 The practice of rubbing the gums of children
 with coral and other hard but smooth bodies,
 in order to make the teeth cut easily, is still
 recommended by all writers on the diseases of
 children. Doctor Underwood observes, “ se-
 “ vere symptoms could not arise merely from
 “ the teeth piercing the gum, which it has
 “ been said is not a very sensible part*.” He
 therefore recommends the use of coral, &c.
 but chiefly depends on the operation presently
 to be mentioned : coral or any other smooth
 hard body which is usually given children to
 bite, with a view to assist the cutting of the
 teeth, I look upon to be a most dangerous
 weapon put into their hands to destroy them-
 selves ; for as the teeth rise and become flight-
 ly elevated above the edge of the socket, those
 hard bodies press and bruise the gum between
 them and the sharp points or edge of the
 tooth underneath : inflammation and its con-
 sequences undoubtedly follow, and in this way

* Diseases of Children, page 214.

I am firmly persuaded the lives of thousands of children have been lost. Doctor Munro warns us against the use of such substances, and recommends the child to be allowed to make use of its own fingers, he does away the old prejudice, that if children were allowed to suck their fingers the size of them would be diminished. I would add to this, that the nurse may now and then rub the gums of the child gently with her finger, where a tooth is about to appear ; children seem to receive great pleasure from it. Every species of gum-stick should be undoubtedly laid aside, a child should not be allowed even a crust of bread, unless the hard outside part was scraped off and afterwards moistened in milk or water.

From these observations it is sufficiently obvious that violent symptoms may arise from the irritation occasioned by the appearance of any one of the temporary teeth or even the permanent. Doctor Rutherford saw a case of chorea produced in a child about eight or nine years of age, by the permanent incisors cutting at the internal part of the mouth
and

and Dr. Munro relates a case of its being produced in a youth by the appearance of the wisdom teeth.

With respect to lancing the gums of children, Dr. Underwood says *, “ When it is found
 “ necessary to lance the gums, (which is ever,
 “ at least, a safe operation) it should always
 “ be done effectually with a proper gum lancet, which will sufficiently divide the gum
 “ or strong membrane that covers the teeth.
 “ The lancet should always be carried quite
 “ down to them, and in certain cases it will
 “ often be proper to draw the lancet along a
 “ great part of one or even both the jaws, at
 “ the same operation. Some writers, however,
 “ ver, and Doctor Millar particularly, have
 “ advised not to cut quite down to the teeth,
 “ but only to scarify the gums, unless the
 “ teeth are very near, for fear of injuring the
 “ succeeding teeth. But this is a needless
 “ scruple, and I apprehend arises for want of
 “ duly attending to the state of the teeth.

* Diseases of Children, Vol. I. Pag. 213, 218, 220.

“ For

“ For the first teeth of infants constantly be-
 “ come carious at the roots, and are loosened
 “ and expelled by that means, when left to
 “ nature alone ; and though the upper parts
 “ of the new teeth are in contact with the ca-
 “ rious bottoms of the first set, they never
 “ suffer from this circumstance. I have,
 “ however, written from *experience*, and am
 “ *perfectly satisfied* of the propriety and safety
 “ of what I have ventured to recommend.”

Doctor Underwood however does not seem
 to have paid much attention to the state of the
 teeth in children, nor indeed to the animal
 œconomy ; if he had, he would not have assert-
 ed that the roots of the temporary teeth be-
 come carious in order that they might be ex-
 pelled. Lancing the gums likewise is not al-
 together so simple or safe an operation as
 Doctor Underwood seems to think, for from
 what I have demonstrated in Chapter IV. re-
 specting the connexion which subsists between
 the temporary and permanent teeth, the con-
 necting membranes and sacs of the permanent
 teeth must have been constantly cut by the com-
 mon mode of operating ; the formation of the
 permanent teeth must of course be much imped-
 ed,

ed, and probably sometimes entirely destroyed, by the frequent repetition of the operation. Lancing the gums of sickly children has sometimes terminated in gangrene and death ; my late friend Surgeon Dease told me he met several instances of this kind. On the whole, the operation has been often performed unnecessarily and without benefit ; complaints, as I said before, arising from totally different sources have been attributed to teething, and recourse immediately had to the lancet. Doctor Hudson says, “ Concerning your question about lancing the gums of children, I have avoided making it a source of revenue to myself, convinced from experience of its futility, except in inflammatory cases, and where the teeth were near the surface ; in such cases the lancet gave relief, and I believe seldom or never on other occasions. Where I have operated by advice of the attending physician, it is true, many children have recovered after the operation, but I could never fairly say the recovery was in consequence thereof.”

When

When we are convinced of the necessity of performing the operation, the incision should be made towards the external plate of the alveolar processes, so as to avoid the connecting membranes and sacs of the permanent teeth, particularly those of the incisores and cuspidati, those of the bicuspidates are more easily avoided on account of the flat and broad surfaces of the temporary Grinders : or two oblique incisions might be made with a similar view, beginning at the internal part and meeting in an angle about the middle of the tooth or external plate of the alveolar process, so that the connecting membranes and permanent sockets might be contained within the space formed by both incisions, the method of doing which can be easily conceived by observing the relative situation of the temporary and permanent sockets as represented in Tab. iii. Fig. 2. Also where advisable a small horizontal portion of the gum might be cut out particularly over the incisores, &c. For these operations the instrument I in general make use of is represented in Tab. viii. Fig. 1.

The

The advantages gained by the operation I conceive are in a great measure owing to the tension of the vessels, &c. being removed by the small quantity of blood drawn from the inflamed part of the gum. I have been particular in pointing out the order and period in which the temporary teeth appear, that we might not err in lancing the gum over the proper tooth, that is, the one which is about to appear*. We should by no means cut or hack the gums in the manner Doctor Underwood recommends, nor do I see any necessity of penetrating so deep, or drawing the lancet over a great part of one or both jaws at the same operation as he also says is sometimes necessary. Doctor Underwood was certainly not aware of the mischief that might be done to the sockets and neighbouring imperfectly formed permanent teeth when he recommends such an extensive incision. Neither can I see the necessity there is of performing the operation nine or ten times over one tooth as Doctor Underwood and Mr. Hunter have done, for,

* Vide Chapter III.

if the gum is frequently lanced previous to the tooth rising above the edge of the socket, its formation is impeded, the root or roots of course do not increase rapidly and they for the most part appear later than they otherwise would do.

By a frequent repetition of the operation I have sometimes seen the temporary incisores appear through the gum imperfectly formed, and soon after their appearance they became loose and fell out, no roots being formed to retain them in the sockets. I shall conclude by saying, that I do not think lancing the gums of children is altogether so safe an operation as has been heretofore imagined, and that great caution should be used in the method of performing it, and also we should be perfectly certain of its necessity. For as I often said before, complaints arising from totally different sources have been attributed to teething, and the children tortured without receiving the slightest benefit or relief by the operation.

It

It is necessary to add that the appearance of the wisdom teeth sometimes occasions a vast deal of uneasiness and pain, particularly when they are formed immediately under the zygomatic process of the lower jaw or tubercle of the upper; this happens where the jaws do not extend sufficiently so as to allow a regular disposition of the teeth, the gum being squeezed and bruised by the frequent motion of the jaw in chewing, becomes inflamed, amazingly tender and painful. Lancing or cutting out part of the gum over the tooth sometimes gives relief. But Mr. Hunter and other modern surgical writers being expert at operating, recommend (in those cases where lancing the gum does not give relief) to have the wisdom tooth taken out, expert indeed they must be who could take out a tooth in such a situation, nor could it be effected without tearing away a considerable portion of the coronoid process or jaw. What I have found answer every intention in such cases, is to take out the middle Grinder, the wisdom tooth soon after moves forward into the place of the former; and the violent symptoms of course cease.

SUPPLEMENT.

S U P P L E M E N T.

SOME time previous to the publication of my inaugural dissertation in September, 1798, whilst assisting Doctor Munro, jun. to arrange some of his father's valuable preparations of the teeth, I observed amongst them an elephant's grinder, and at once discovered its beautiful structure and likewise the manner of its formation. In order to ascertain these facts I got permission from the Doctor after my own plan to have a longitudinal section made of it and afterwards polished, one half of which he kindly presented me with. I immediately showed and explained its structure, &c. to my learned friend Doctor Rutherford and also to Doctor Munro, sen. as well as many other gentlemen. A drawing was copied from it by Mr. Alston, which I entrusted to an ingenious artist Mr. Scott to engrave for me, the

plate of which I intended to have annexed to my thesis, but found it could not be finished in time for the graduation, of course I reserved it for the present work.

At this period John Corse, Esq. came down from London to Edinburgh, and as he had made many interesting and valuable observations in the East Indies on the œconomy and natural history of the elephant, and also on their mode of dentition, Doctor Munro mentioned to him the discoveries I had made on the structure and formation of the teeth in general and particularly on the grinders of the elephant, and shortly afterwards was kind enough to introduce me to him. Mr. Corse told me he was not at all acquainted with the structure of the elephants teeth nor indeed with the structure of the teeth of any graminivorous animal, that his object alone was to point out what he said he had discovered, scil. “ The mode of dentition of the elephant,
 “ or the progressive motion of one grinder
 “ into the place of another in proportion as
 “ the anterior one is worn away.” Accord-
 ing

ing to appointment we met at my apartments in order that I might demonstrate my preparations of the teeth in general to Mr. Corse : which I did, and also explained to him how a section should be made of an elephants grinder to show its internal structure, a section similar Mr. Corse confessed he never before saw. Doctor Munro, jun. and my friend Doctor William Armstrong were present at this demonstration. Mr. Corse told me he would undoubtedly do me justice, and that he would mention my discoveries of the structure and formation of the elephants grinders in his intended publication on the different species of Asiatic elephants and their mode of dentition.

Mr. Corse requested me to meet him in London, and that he would give me permission to prepare, in any manner I pleased, several valuable preparations of the heads of elephants he had collected and brought from the East, and to publish drawings from them according to my own plan ; unfortunately I could not at that time take advantage of his kind offer.

Mr. Thomas Blizard of the London Hospital was in Edinburgh nearly at the same time; to whom also I demonstrated my preparations.

The engraving of the elephants grinder being finished in October 1798, I gave impressions of it to Doctors Munro, Rutherford, Armstrong, &c. and to Mr. John Bell, Mr. Alexander Ramsay, and many other gentlemen. Mr. Corse had left Edinburgh previous to this period.

Having returned to Dublin in November 1798, I determined as soon as possible to visit London and avail myself of Mr. Corse's generous offer, but could not arrange my affairs so as to go there until September 1799. On my arrival in London I immediately waited on Mr. Corse, and found to my very great astonishment as well as disappointment, that he had already published a section similar to mine of an elephants grinder, without once mentioning my name as having originally discovered its structure and formation, and
also

also some other of my observations which shall afterwards be noticed *. Mr. Corse endeavoured to apologise to me for this conduct, by saying, that he had explained my observations to Mr. Everard Home of London, and also that he had put my thesis (a copy of which I presented Mr. Corse) into his hands, Mr. Corse therefore *supposed* Mr. Home would have mentioned my discoveries in his intended work which was to have been added as a supplement to Mr. Corse's. However on looking over Mr. Home's work †, I was not a little surprised to find that he (Mr. Home) had published most of my discoveries as his own, respecting the teeth of graminivorous animals, and artfully contrived to alter some of the terms I made use of; for instance, what I have uniformly called bone Mr. Home calls ivory, and what I have called the crusta

* Mr. Corse's observations on the different species of Asiatic Elephants. Tab. XII. Philosophical Transactions for 1799.

† Mr. Home's observations on the Structure of the Teeth of graminivorous quadrupeds. Philosophical Transactions for 1799.

petrosa Mr. Home calls bone. He has of course avoided mentioning my name or referring to my thesis.

Having brought to London with me a few impressions of the plate representing my section of the elephants grinder, I presented them, and at the same time explained this illiberal transaction and my priority of claim to the discovery of the structure and formation of the teeth of graminivorous animals in general to several of the first medical characters I had the honor of being introduced to, and also to that liberal patron of science the president of the Royal Society, Sir Joseph Banks. This in some measure reconciles me to the unforeseen delay of its appearing previous to this period. I have also to add the pleasing reflection of my priority of claim being established and supported by the University of Edinburgh.

It now remains for me to expatiate a little on both these works, (scil. Mr. Corse's and Mr. Home's) and to explain the structure and formation of the elephants grinders, which
(notwithstanding

(notwithstanding the advantages Mr. Corse and Mr. Home have had in the possession of my thesis and observations) neither of them as yet perfectly understand; and although I have had an opportunity of seeing all Mr. Corse's and Mr. Hunter's valuable preparations I do not find it necessary to deviate in the slightest degree from the manner in which I originally explained their structure and formation to Mr. Corse.

As many very valuable and interesting observations have been made by several authors on the different species of elephants, their mode of dentition, as well as the structure and formation of their grinders, most of which were published in the Philosophical Transactions about the beginning of the last century, I shall occasionally refer to them.

I mentioned to Mr. Corse in Edinburgh, that the pulp of an elephants grinder was divided into a number of conical processes, and that duplicatures of the investing membrane passed down between these processes to form
the

the cortex striatus—that ossification commenced on the highest point or points of these processes, and formed conical bony shells on them, which extended downwards for many inches previous to the junction of their sides—that as soon as the bony shells were perceptible the internal lamella of the investing membrane began to deposit the soft earthy matter of the cortex striatus on their external and upper surface, and that as soon as it was crystallized on the upper part of the shells, the investing membrane assumed a different mode of action and began to deposit a crusta petrosa on their points and sides, in order to fill up the interstices or spaces between the shells where the membrane passed down to form the cortex striatus, in a similar manner to those of the horse—that previous to the appearance of the tooth through the gum, one continued line of the cortex striatus could be traced as far as the ossification and junction of the sides of the shells were complete, but that in proportion as the tooth came into use and was worn down by grinding, the connexion of the cortex striatus, as well as that of the crusta petrosa, were cut off, that then the crusta petrosa

trofa and bony part appeared alternately between the ridges or plates of the cortex striatus on its grinding surface—that as ossification advanced the pulp extended and sent off processes to form roots, that the tooth rose and continued to rise by the formation and addition of new bony matter to the roots, in proportion to the detrition of the grinding surface, until the entire tooth was worn away—that the *crusta petrosa* was deposited on the external surface of the tooth as long as any portion of it remained within the jaw—that the junction of the sides of the shells and plates of the cortex striatus was in every respect similar to what I had observed in the teeth of other graminivorous animals.

I then showed and explained to Mr. Corse my section and drawing of the elephants grinder as represented in Tab. VIII. the tooth being perfectly formed and a considerable portion of it worn away by grinding. The *crusta petrosa* is represented externally, which the figures 1, 2, 3, 4, &c. denote. One continued winding line of the cortex striatus can
be

be traced commencing at *e*, until it is cut off by grinding as at *c*. The bony part on which the fibres of the cortex striatus are arranged appears wavy as at *a*, and the junction of the bony shells and cortex striatus is shown at *d. d. d.* The plates of the cortex striatus at 12, had been originally nearly as long as those at the opposite side, and the vessels entered the hole at *b*. to nourish the remains of the pulp contained in the cavity of the tooth; the roots are sufficiently distinct. I shall now request the candid reader to compare this plate with that of Tab. 12. of Mr. Corse's work, and also with Tab. xiii. xv. and xvii. of Mr. Homes. Also to compare Fig. 5. Plate 5. of my thesis, with that of Mr. Corse's, Tab. viii. Fig. 1. and 2. from which figure the idea of both these were taken, to show the junction of the bony shells, and how the pulp becomes separated from the investing membrane.

I mentioned in my thesis, (page 81), that the crusta petrosa was much harder and more brittle than the proper bony part of a tooth,
but

but less hard and brittle than the cortex striatus, and that of course it did not wear down so fast as the bony part. In this probably I have been too nice, for in one case the crusta petrosa wears faster than the bone, in another the bone wears faster than it, and although in the cow, sheep, &c. it is more brittle than the bony part, in other animals it may not be, nor is it so hard on the tusks of the spermaceti whale, sea cow, nor even on the grinders of the elephant.

In one of the interviews I had with Mr. Corse in London, and at which Doctor William Armstrong was present, he said the reason why he did not mention the substance I called the crusta petrosa in his work was, that in about a month after he had seen me in Edinburgh, he had several conversations with Mr. Home in London on this subject, and that on showing Mr. Home my thesis and his valuable preparations (the physiology of which Mr. Home at that time was not well acquainted with) Mr. Home said the substance I called the crusta petrosa was not materially different
from

from common bone, and that it would be found softer than the centers of the strata composing the grinder ; and because, on polishing a section of one of the elephants grinders, this substance was found softer than the bone, Mr. Corse said he gave up the idea of a third substance entering their composition. This is a flimsy excuse indeed, for as I mentioned in my thesis the *crusta petrosa* differs in colour as well as texture and formation from the other two component parts of the tooth, scil. the *cortex striatus* and bone. Mr. Corse however in his work has altered the appellations I made use of and slyly marks the three different component parts of the tooth ; for instance, in explanation of Plate xii. he calls the *crusta petrosa* the *bony crust*, and the proper bony part of the tooth he calls the *bony matter*. Explanation of Plate xii. *F. F. F. G. G. H. H. H.*

After this simple statement of facts Mr. Home has the modesty to assert, “ From these
 “ two sources (viz. Mr. Corse’s observations
 “ and preparations, and also preparations of
 “ the elephants teeth preserved in spirit in
 “ Mr.

“ Mr. Hunter’s collection) I was enabled to
 “ procure every information that was requir-
 “ ed, to explain the structure of the elephants
 “ teeth and to point out the general principle
 “ upon which all teeth are formed that have
 “ the enamel intermixed with the substance
 “ of the tooth ; *a subject, as far as I am ac-*
 “ *quainted, not hitherto investigated.*” Mr.
 Home adds, “ I was desirous that the facts
 “ which I *had discovered* respecting the
 “ *structure* of the elephant’s teeth, should be
 “ introduced into his paper, to render the
 “ account more complete : this offer, Mr.
 “ Corse however declined, not choos-
 “ ing to bring forward any thing that was not whol-
 “ ly his own*.” Did Mr. Home suppose
 that my discoveries and observations on the
 teeth of man and various animals (because
 they were published in a *thesis*) would be
 thrown aside and not noticed? Did Mr. Corse
 and Mr. Home suppose I would not, or could
 not vindicate my own priority of claim and

* Mr. Home’s observations, &c. Philosophical
 Transactions for 1799, page 1 and 2.

make this transaction public ? I do it in support of science, more than for my own celebrity ; I do it to put a stop if possible to such plagiarisms, and give a zest to those who are engaged in the studies of Nature.

To enter into a full refutation of many of the principles laid down by Mr. Corse and Mr. Home would be foreign to my present purpose, I cannot however pass over some of their remarks and erroneous ideas. Mr. Corse says, (page 9) “ A grinder is composed of several distinct laminæ or teeth, each covered by its proper enamel ; and that these teeth are merely joined to each other by an intermediate substance acting like a cement.” This was the opinion of the celebrated Ray *. It was also the opinion of Doctor Patrick Blair, who has displayed great anatomical knowledge, perseverance and accuracy, in his dissection of an elephant that died at Dundee in Scotland,

* “ Plurimi dentes in os solidum et durum ita infixi sunt, ut cum eo et inter se unum et continuum corpus efficiant.” *Synopsis Animal. Quadruped.*

An. 17c6. He very nearly discovered the structure and formation of their teeth, but calls the bony shells the rudiments of the teeth *,

“ Several of which rudiments he observed
 “ lying stratum super stratum or placed per-
 “ pendicularly across the jaw, they were two
 “ or three times intersected by membranes
 “ whereby they could be disjoined, but after
 “ he had taken out several of these rudiments,
 “ he observed no more such separation.
 “ Where the ligaments cease they become ex-
 “ tremely solid and ponderous, and at their
 “ upper extremity half round and sometimes
 “ formed into digitations, from which there
 “ run several ridges and sulci †. ’Tis observa-
 “ ble, that at their upper extremity there is a
 “ *lamina*, which being convex toward the
 “ jaw, and concave toward these rudiments of
 “ teeth, does as it were knit their solid extre-

* Philosophical Transactions abridged by Henry Jones, Vol. V. Part I. Page 120.

† Tab. ix. Fig. 2. *a. b.* of my Essay, this drawing of one of the rudiments or rather shells was copied accurately from Plate vi. Fig. 90. of Doctor Blair’s, it is not however near the natural size.

mities

“ mities together, before they appear without
 “ the jaw.” It was likewise the opinion of
 Doctor T. Molyneux *, Tentzelius †, and
 others.

If an elephant's grinder was composed of
 several distinct teeth and if each of them
 were covered by its proper enamel, there
 should have been different pulps and mem-
 branes to form each tooth : but it is not so, there
 is (as I told Mr. Corse) but one pulp which is
 divided into a number of conical processes, and
 in proportion as the anterior processes are ossifi-
 ed, the pulp sends backwards a certain num-
 ber of additional processes, to enlarge the tooth,
 such as are noticed in my thesis, page 78. If
 likewise a grinder (or case of teeth) as Mr.
 Corse calls it, was formed of a number of teeth
 merely cemented together by an intermediate
 substance, there could not be that beautiful
 winding and continued line of the cortex
 striatus over the bony part which I discovered,
 and which is represented in Plate ix. Fig. 1. as

* Philosophical Transactions abridged, Vol. IV. Part
 II. Page 238.

† Ibid. Vol. II. Page 440.

far as the junction of the sides of the shells is complete, and which connected line as well as the arrangement of the fibres of the cortex striatus Mr. Corse and Mr. Home have represented after my plan, although the fibres of the cortex striatus, owing to the peculiar arrangement of them, are not so distinct in a section or fracture of an elephant's tooth; as in those of the cow, &c.

I have shown that Dr. Blair in a certain degree noticed the substance I have called the *crusta petrosa* in the elephants grinders, but in addition to his ingenious remarks I will add those of the Rev. Mr. Morton, which are introduced in Sir Hans Sloane's Essay on the teeth and bones of elephants*. Mr. Morton says, " The grinder whole, or however all
 " the pieces of it I could find (for it was broken
 " into three or four in taking it up) being put
 " together as they grew, exhibit thirteen or

* Philosophical Transactions abridged, Vol. VI. Part III. Page 30.

“ fourteen parallel lamellæ ; each of which
 “ extends the whole length and almost the
 “ whole thickness of the tooth ; and of these
 “ for the main it is composed. But in a live
 “ or perfect tooth these lamellæ do not appear
 “ so plainly, being in part crufted over with a
 “ white offeous cruft or integument, which in
 “ this fossil tooth is almost wholly perished
 “ and gone, infomuch that the lamellæ are
 “ more expofed to view. From the root to
 “ the top in the longeſt part, which is near the
 “ middle of it, it is juſt ſeven inches long.
 “ None of the lamellæ are contiguous ; there
 “ interpoſes betwixt them a thinner plate of a
 “ white colour and a laxer texture. Three
 “ or four of the outmoſt at one end of the pile
 “ appear undulated at the top of the tooth, are
 “ near as broad at top as at the root, and
 “ have a blunt ending. The reſt of them are
 “ by degrees contracted to a point, are gradu-
 “ ally ſhorter and ſhorter to the other extre-
 “ mity of the pile, and alſo bend a little over
 “ one another. And each of them, as it ap-
 “ proaches the top divides, as it were, into
 “ ſeveral ſmaller teeth.” This deſcription of
 Mr.

Mr. Morton's is very accurate and concise ; if he had made a section similar to mine, he would have noticed the three component parts of which an elephant's tooth consists ; the substance I have called *crusta petrosa* he calls the *osseous crust*, but did not understand the manner of its formation ; in this respect Dr. Blair was better acquainted with the subject.

I have mentioned in my thesis, page 81, that the investing membrane, after it had deposited and perfected the cortex striatus on the teeth of graminivorous and ruminant animals, assumed a different mode of action, and deposited the *crusta petrosa*—that the upper grinders in general of the horse remained sufficiently long under the gum to allow the internal cavities to be filled with the *crusta petrosa*, otherwise they would be filled with broken particles of the teeth and food, as they are in the cow, sheep, deer, &c. the nourishment being cut off from the internal duplicatures of the membrane by the appearance of the tooth. But as an elephant's grinder is differently constructed, the processes of its pulp and shells

O 2

being

being placed almost perpendicularly across the jaw, and the interstices between them extend from one side of the socket to the other, the internal duplicatures of the investing membrane continue to be nourished from the sides, even after the upper part of the tooth has been perfected, and that part of its membrane wasted by the appearance of the tooth through the gum. This beautiful contrivance was necessary, otherwise as the processes of the pulp elongate and the bony shells extend downwards on them many inches previous to the junction of their edges, the upper part of the cavity or interstice between them would be filled by the *crusta petrosa*, whilst the lower part of it would be empty, which sometimes, tho' seldom, happens in the upper grinders of the horse. The tooth would not be so strong or lasting as it is, nor would the earthy matter of the *cortex striatus* be perfectly crystallized down to the junction of the shells, but remain in a soft state.

As the lower and alternate edges of the shells must be joined, previous to the deposition

tion and crystallization of the cortex striatus on that part of the tooth, a space is seen in Tab. ix. Fig. 1. a little above *d*. which was not at this period filled by the crusta petrosa. In this growing tooth (with which Mr. Corse was liberal enough to present me) several of the posterior shells were as yet quite separate, sections of two only of them are represented, which will give an adequate idea of the others, excepting that they are progressively smaller; the number of these shells varies according to the kind of tooth or age of the animal, being from four to twenty-three*. In fossil teeth I have however counted thirty-four of them. In proportion as ossification advances and the cortex striatus is perfected, the crusta petrosa is deposited, fills up the interstices between the shells, and unites them in a certain degree at the upper part a long time previous to the junction of the edges of the shells at bottom, this must necessarily happen on account of the gradual progress of the formation of the tooth, and which can be easily understood by

* See Mr. Corse's Observations, page 11.

viewing

viewing Plate ix. Fig. 1. If the shells, as Mr. Corse says, were different teeth and merely cemented together by the *crusta petrosa*, it would pass down quite through the entire substance of the tooth ; but it does not, it terminates at the junction of the bony shells and plates of the *cortex striatus*. The *crusta petrosa* serves a purpose similar to that noticed in Chapter VIII. with respect to the teeth of the horse, &c. it extends considerably beyond the shells and renders the interstices between them smooth, as Mr. Morton well observes. In proportion as the alternate edges of the shells unite, they complete the body of the tooth from which the roots commence : the tooth represented in Tab. ix. was not sufficiently advanced to have roots formed, but in Tab. viii. they are represented perfectly formed, which gives a sufficiently accurate idea of them.

In proportion as the rudiment of the first grinder is tolerably advanced, its membrane sends backwards a process to form a second, (and from the second to the third, and so on,) both

both of which are at first contained in the same socket, but as ossification advances they become separate : a hole of communication however is preserved, through which the connecting membrane passes. This connexion Mr. Corfe speaks of (page 14,) and borrowed the idea from my observations, but did not mention it as my discovery, because Mr. Home told him “ he did not think it worthy of notice.”

Dr. Moulins, Dr. Blair, Dr. T. Molyneux and many others were very much at a loss to determine the number of grinders an elephant in general ought to have, on account of the irregular situation of the teeth in different elephants, and also the use of those they observed in an incipient state ; Dr. Moulins says in his anatomical account of the elephant accidentally burned in Dublin in the year 1681, (London 1682) page 40. “ There were besides the tusks only four teeth in each jaw, two in every side, he had no incisores. The length of each of the inner teeth of the lower jaw was about six inches and a
“ half

“ half, but the outward of the same jaw was
 “ only one inch and three quarters long.
 “ The length of the hinder tooth in the right
 “ upper jaw was four inches, but that of the
 “ opposite was but three, the two outward
 “ teeth of the upper jaw were somewhat long-
 “ er than those of the under, the greatest
 “ breadth of the teeth was two inches and three
 “ quarters, the height of the teeth above the
 “ jaw was about one inch and three quarters.”

Dr. T. Molyneux ingeniously observes *, “ It
 “ appears that the number of molares in the
 “ elephant is not certain ; and although by
 “ the observations of Mr. Du Verney, Dr.
 “ Moulins, and Dr. Blair, who dissected three
 “ different elephants, it appears that each of
 “ them had eight molares, yet in the division
 “ of them nature observes no rule ; for Dr.
 “ Moulins found that in the upper jaw the
 “ inner tooth on one side was bigger than its
 “ fellow, and Mr. Du Verney and Dr. Blair
 “ had on both sides the much greater tooth

* Philosophical Transactions abridged, Vol. IV. Part
 II. page 244.

“ outwards :

“ outwards: whereas the Westminster skull,
 “ on the contrary, has only a small one out-
 “ wards, and the much greater grinder within.
 “ In this skull there were only six teeth, viz.
 “ one in each lower jaw, and two in each of
 “ the upper; the upper small teeth are much
 “ worn by grinding, and both together are
 “ about an inch longer than those of the un-
 “ der jaw; the upper teeth have a convexity
 “ which answers to the concavity of the un-
 “ der teeth, a circumstance not observed by
 “ any one else.” It is singular that Dr. Moly-
 neux did not benefit by the remarks of Dr.
 Blair on this subject, most of which are very
 interesting. Dr. Blair says, (page 116, 117 and
 “ 121,) In the upper jaw there are two teeth
 “ at each side, the back one of which does not
 “ grind, but serves, as it were a wedge, to keep
 “ the anterior firm in its place. Dr. Moulins
 “ takes no notice whether the hinder teeth of
 “ the upper jaw grind or not; but here as I
 “ have said, not only both the hinder teeth are
 “ free from grinding, but also part of the fore
 “ teeth (tooth he means) of the left side. The
 “ situation of these teeth, for what I know, is
 “ peculiar

“ peculiar to this animal. The teeth of the
 “ lower jaw exceed those of the upper about
 “ two inches in length, by which it appears
 “ that the motion of the lower jaw must be
 “ very great in mastication, and that the ele-
 “ phant for the most part moveth the jaw
 “ from behind to before ; and scarcely from
 “ one side to the other, as in animals that ru-
 “ minate or chew the cud.” This last obser-
 vation of Dr. Blair’s is perfectly just with
 respect to the motion of the under jaw in
 grinding, the sockets and condyles of their
 jaws are beautifully constructed for this pur-
 pose, and although the upper teeth of the ele-
 phant described by Dr. Molyneux were longer
 than those of the under, it very seldom hap-
 pens so, if my recollection does not fail me.
 The motion of the under jaw of the beaver is
 similar to that of the elephant, and although
 the rabbit, hare, &c. move their jaws likewise
 from behind to before, they possess in addition
 a considerable lateral motion. Dr. Blair adds,
 (page 121) “ Before we quit the lower jaw,
 “ I hope it will not be impertinent to enquire,
 “ whether or no these *rudimenta dentium* may
 be

“ be supposed in process of time to descend and
 “ expel those teeth already formed, and succeed
 “ in their place.” The ingenious Dr. Blair,
 having had but one elephant to examine, could
 not follow up this idea, he reasons rather against
 the possibility of its taking place, and adds
 many arguments *pro* and *con* too numerous to
 insert. Mr. Corse, however, claims the entire
 merit of this discovery ; I think he ought
 to have noticed Dr. Blair’s observations and
 should not say, “ The ingenious Dr. Blair,
 “ far from suspecting a regular succession of
 “ the grinders, attempts to prove such successi-
 “ on to be impossible. He is equally erro-
 “ neous in many other respects, (page 10).”
 Mr. Corse however has (by the very great ad-
 vantages he possessed, and the great industry
 exemplified in collecting so many heads of
 elephants of different ages,) thrown great light
 on this idea of Dr. Blair’s, and cleared up the
 difficulties the older writers laboured under,
 respecting the number and situation of the
 teeth in different elephants, and observes,
 (page 13,) “ An elephant may at one period
 “ have only a single grinder in each side of
 “ either

“ either jaw, (Mr. Corse I suppose means in
 “ use) at another period, there may be one and
 “ part of a succeeding grinder ; even a still
 “ greater variety in the appearance of the
 “ grinders will take place according as the an-
 “ terior one is more or less worn away and the
 “ waste supplied by its successor.” These facts
 are beautifully exemplified in plates annexed
 to Mr. Corse’s work.

Mr. Tenon has published an account of his
 observations on the structure and formation of
 the teeth of graminivorous animals, particularly
 the horse, in the Mémoires De L’Institut Nati-
 onal des Sciences et Arts, Paris, Thermidor
 an. VI. answering to the year 1798 of our
 stile, some short time previous to my thesis
 being printed. He notices the substance I
 have called the *crusta petrosa* and calls it the
cortical osseux or simply *cortical**, the other
 two component parts he calls bone and ena-
 mel. He has taken considerable pains to as-

* Tom. premier. Sciences Mathematiques et Phy-
 siques, page 568.

certain and point out the age of a horse by the wearing down of his front teeth, the structure of which he seems better acquainted with than that of the grinders, he gives drawings and sections of the first but no sections of the latter, and does not observe the difference between the upper and lower grinders; his work however contains many ingenious observations, and although he did not enter with sufficient minuteness into either the structure or manner of formation of their teeth, yet his work merits particular attention. With respect to the manner and formation of the *crusta petrosa*, he supposes the investing membrane becomes ossified, he was aware however that the enamel was first formed, and says, (page 611) “*Que la formation de l’émail précède l’ossification de la membrane qui produit le cortical.*” I have asserted that the *crusta petrosa* is merely a deposition by the membrane; if the investing membrane was ossified, the body of the tooth would not have an external periosteum; the use of the *crusta petrosa* and membrane I have frequently noticed. Mr. Tenon likewise observes, that the *crusta petrosa* is softer than the

the bony part, and mentions it is to be noticed on the grinders of the elephant, &c.

This essay of Mr. Tenon's was in the library of a friend of mine in London some months previous to my visiting that place in September 1799, whether Mr. Home saw it or not I cannot pretend to say, he has however hit on the idea of Mr. Tenon with respect to the formation of the *crusta petrosa*, for he says, (page 7) "The intermediate substance which may be called bone, was formed upon a species of ligament situated immediately underneath the gum." This substance (the *crusta petrosa*) differs materially from bone, for it is neither fibrous nor lamellated, nor are thin sections of it near as transparent as those of bone, and although Mr. Home says, (page 5) "It proves to be similar, in its texture and formation to common bone," yet in another part of his work he contradicts himself, for he well observes, (page 21) "In the bony part (*scil.* the *crusta petrosa*) there are no distinct fibres nor laminæ." The name I have annexed to this substance, in order to distinguish it from the other component parts

parts, I do not think necessary to alter, if I did I would adopt that of the *osseous crust* given it by the ingenious Mr. Morton. Mr. Home endeavours to apologize for Mr. Hunter's not discovering the structure and formation of the teeth of graminivorous animals by saying, (page 7 and 8) " To show the figured
 " appearance on the grinding surface of horses
 " teeth, Mr. Hunter rendered them black by
 " means of fire, which did not affect the ena-
 " mel, so that the white lines of the enamel were
 " beautifully distinct on the black ground :
 " but the bony part and the substance of the
 " tooth were equally coloured, and had an uni-
 " form appearance. The examination of these
 " preparations led him to believe, that the
 " horse's tooth consisted of only two substan-
 " ces, the tooth itself and the enamel." Mr. Home's theory with respect to the formation of the cortex striatus is rather curious, he says, (page 4) " This pulp is inclosed by a capsule,
 " the cavity of which, while the tooth is grow-
 " ing, is filled with a viscid fluid, similar to
 " the synovia of joints ; and this fluid, by the
 " absorption of the thinner parts, becomes in-
 " spissated

“ spissated to a proper state for crySTALLIZATION,
 “ so as to form the enamel, which adheres to
 “ the surface of the tooth.” I shall just ask
 Mr. Home, what deposits the mucilaginous
 fluid? to answer for him, the investing mem-
 brane. My ideas and the facts I have disco-
 vered on this subject are so frequently noticed
 in this essay, that they need no recapitulation.
 If Mr. Home’s ideas were just, how does it hap-
 pen that in the incisores of some animals such
 as the beaver, &c. only one side of the tooth
 is covered with the cortex striatus, although
 the body of the tooth was surrounded by the
 investing membrane?

With respect to the different species of ele-
 phants, Mr. Corse and Mr. Home might have
 referred to the ingenious observations intro-
 duced in Dr. Blair’s work (page 110) by Ta-
 vernier on the difference between the elephants
 in India and those of the island of Ceylon,
 and also Mr. Strachan’s observations on the
 method of taking and taming wild elephants
 in Ceylon, and their different species *. With

* Philosophical Transactions abridged, Vol. V. Part
 II. page 176.

respect to Plate xvi. of Mr. Home's observations, which he gives to mark the difference between the Asiatic and African elephant's tooth, he will meet drawings precisely similar given by Dr. F. Molyneux in the fourth Volume of the Philosophical Transactions abridged, Part II. Plate III. page 252. The difference between the Asiatic and African elephant is more fully explained by Cuvier* ; and Blumenbach has given drawings of a grinder of each in his objects of Natural History. The grinder of the African elephant contains a much greater portion of the crusta petrosa than the former, the appearance of the grinding surface is likewise different.

The grinders, &c. of an unknown animal supposed extinct, have been found in a fossil state intermixed with the tusks and bones of elephants, near the banks of the river Ohio in

* Mém. de L'Institut. Nat. Des Sciences, Paris, Fructidor An. VII. Mémoire sur les Espèces D'Éléphants vivantes et fossiles, par le Citoyen Cuvier. Pl. 1 and 2.

North America, accurate drawings of their full size and a description of them are given by Peter Collinson, F. R. S. in the fifty-seventh Volume of the Philosophical Transactions for 1767, page 464. These teeth were supposed to belong to another species of elephant, but as Mr. Collinson well observes, when compared with the grinders of an elephant, they exhibit a very different appearance. They are in length generally about seven or eight inches, and from three and a half to four inches in breadth ; they are formed nearly in a similar manner to the human grinders, their bodies being entirely covered by the cortex striatus, its thickness is twice greater than that on any other animal's tooth I have met with, being upwards of a quarter of an inch ; the fibres of which it is composed are perfectly evident, and although it does not pass down through the substance of the tooth, the grinding surface (owing to the irregular disposition of the bony lamellæ) is very rugged. There is not the slightest appearance of a crusta petrosa, so that the tooth consists of but two substances. The appearance of the grinders induced the learned
Dr.

Dr. William Hunter to rank this creature amongst carnivorous animals, but the celebrated Camper differs from the Doctor, because the incisores and cuspidati are wanting in this beast, which are the principal characteristics of carnivorous animals: Mr. Cuvier in support of Camper's opinion refers to the rhinoceros, whose teeth in a certain degree resemble those we have been speaking of, so that they suppose it lived on the branches of trees, &c. I think however it is most probable the creature lived alternately on animals and vegetables, and of course was omnivorous.

With respect to the formation of the tusks of the elephant, Dr. Blair well observes, (page 111)
 “As to their structure, I doubt not but they
 “have been composed at first of a mucilaginous substance, as teeth are; and that afterwards they augment by the apposition of
 “several laminæ or strata, according as the
 “animal increases in years.” That they are composed of lamellæ placed one within the other, Sir Hans Sloane has clearly demonstrated, and has given accurate drawings to

support his opinion *. He says, (page 24)
 “ The structure of these tusks, and conse-
 “ quently of ivory in general, is layer upon
 “ layer or coat upon coat, like the skins in an
 “ onion, or rather the annual circles or rings
 “ in trunks of trees.” The outer lamella
 according to my observations is longest, the
 internal lamellæ become shorter and shorter,
 and the last formed is shortest.

Concerning the teeth of the Rhinoceros
 I have been incorrect, I have mentioned in
 my thesis (and introduced the remark into the
 present Essay, page 87,) that I observed the
 crusta petrosa on its teeth: this was from re-
 collection, three years intervening since I saw
 one in London which was stuffed, and could not
 meet with one of their teeth in Edinburgh.
 They are as Mr. Home mentions, (page 19)
 composed only of two substances, scil. bone
 and the cortex striatus.

* Philosophical Transactions abridged, Vol. VI. Part
 III. Page 24. Plate III.

Mr. Home has not described the structure of the cow's grinder as accurately as the ingenious Mr. Clift drew it, he has represented the tooth as it really is, in general composed of four different substances, (Tab. xx. Fig. 2.) the internal cavities filled with adventitious matter are drawn black, the bony part of a lighter colour, the windings of the cortex striatus are easily distinguished, and the crusta petrosa on the external sides of the tooth is represented white. Mr. Home observes, that a cow's tooth consists of but three substances, and that the internal cavities are filled by the crusta petrosa or what he calls bone. This is an egregious error, and in one interview I had with him in London I could not persuade him to the contrary, although he told me he had seen my thesis and observations on this subject. A similar and greater mistake he has committed with respect to the grinders of the sheep, for their interstices are likewise drawn by Mr. Clift black, as they really are, (Tab. xx. Fig. 3.) being constantly filled with particles of grass, clay, &c. Yet Mr. Home says they are filled by the crusta petrosa, and adds,

adds, there is none of it on the outside of the tooth. Mr. Home did not understand that in young animals it easily chips off as I formerly mentioned, which was most probably the case in the specimen he examined, and as sheep are commonly killed early in life and also cows, the quantity of the *crusta petrosa* on their teeth cannot be in proportion to that on an old horse's tooth, with which Mr. Home compares them. And in the horse's tooth where part of the cavity had been filled with the particles of food, &c. Mr. Home observes in explanation of Tab. xx. Fig. 1. "The two
 " holes were probably to give passage to arte-
 " ries, and were enlarged by the food falling
 " into them, *and wearing away their sides,*"
 These are original remarks indeed.

I shall now take the liberty of referring the Right Hon. and Hon. the Members of the Royal Society to my Thesis, which (by their letter of thanks, dated London, May 9, 1799, and signed by their secretary, E. W. Gray, Esq.) they received from me. And with the testimony of Dr. Monro, sen. in support of
 my

my priority of claim, I shall conclude this subject.

SIR,

In November last I received a letter from you, dated Dublin, October 25, 1800, in which you asked me to mention what you showed me, in October 1798, relating to the structure of the teeth in the elephant. In answer to this, I can have no hesitation in declaring,

That in autumn 1798, one of the molares of an elephant, which had been for a considerable time in my possession, was, at your request, sawed perpendicularly.—That a drawing and engraving of this, of its full size were executed by your direction.—That in October 1798, you gave me a proof of this table, which I preserved and which is now before me. On one corner of it I find engraved—*drawn by William Alston*, and on the other corner *engraved by R. Scott*, and under it *published as the act directs 1798, by R. Blake,*

Blake, M. D. You had painted those parts of the tooth, which are outside the plates, of enamel of a yellow colour ; and you had written on the margin, below the table, *The yellow parts represent the crusta petrosa.* *R. B.*

One half of the tooth is still in my possession, and, with it, a thin section from the same tooth, in which I have made the distinctions of *enamel*, *osseous substance*, and what you called *crusta petrosa*. more evident, by having exposed it to heat.

I am, Sir,

Your most obedient servant,

Alexander Munro, Senr.

Edinburgh, Jan. 25, 1801.

For Dr. BLAKE.

EXPLANATION
OF THE
FIGURES.

TABLE I.

FIG. 1. Represents the rudiments of the teeth of a foetus, about four months after conception, taken from the left side of the lower jaw, a. a. b. c. c. the membranes, &c. of the temporary teeth, a. a. the membranes of the incisores, b. the membrane of the cuspidatus, c. c. those of the grinders, d. the membrane of the anterior permanent grinder, e. the gum, f. the vessels &c. g. g. h. i. k. the bony shells taken out of the membranes, g. g. the shells of the incisores, h. the shell of the cuspidatus, i. those of the anterior grinder, which commenced by two points of ossification, k. one shell only which was at this period formed on the posterior grinder.

FIG. 2. Represents the left side of the lower jaw of a foetus about five months; the internal plate of the alveolar process being cut away, a. a. b. c. c. the membranes

branes of the incisores, cuspidatus and temporary grinders, a. a. the membranes of the incisores, b. the membrane of the cuspidatus, c. c. those of the grinders, d. the membrane of the anterior permanent grinder, e. the vessels, &c.

FIG. 3. Represents an internal view of the rudiments of the teeth, taken from the right side of the upper jaw of a foetus, between eight and nine months old, a. a. b. c. c. the rudiments of the temporary incisores, cuspidatus and grinders, d. the membrane of the anterior permanent grinder, e e. f. the incipient sacs of some of the permanent teeth, e. e. those of the incisores, f. the sac of the cuspidatus, g. g. the gum, h. h. i. k. k. the shells of the temporary teeth separated from the membranes, h. h. those of the incisores, i. the shell of the cuspidatus, k. k. the shells of the grinders, l. one shell which had commenced on the anterior permanent grinder.

Fig. 4. 5, and 6. Different sections of the lower jaw, and rudiments of the teeth of a child about seven or eight months after birth. This preparation had been preserved in spirits of wine, so that the parts are very much contracted, it was not injected with wax, but made with an intention of showing the nerves entering the pulps; the condyles, &c. have been entirely cut away.

Fig. 4. Represents an external view of it, a. a. the middle temporary incisores, which had nearly penetrated the

the gum, it appears slightly elevated over them, b. b. their roots, c. one of the lateral incisores, d. the cuspidatus, e. part of the sac of the permanent cuspidatus, f. f. the temporary grinders, g. the anterior permanent grinder, h. the incipient sac of the middle permanent grinder, i. the vessels, nerve, &c.

Fig. 5. An internal view of the same preparation: in order to show the sacs of the permanent teeth, part of the alveolar processes have been cut away, a. a. the gum slightly elevated over the middle temporary incisores, b. b. the connexion, membranes, &c. of the middle permanent incisores, c. c. those of the lateral incisores, d. d. those of the cuspidati, e. the commencement of the sac of the anterior bicuspidis, f. g. the temporary grinders.

Fig. 6. a. the sac of one of the lateral incisores turned up, to show the intimate connexion which subsists between it and the membrane b. of the temporary incisor, c. the sac of the middle permanent incisor, d. the gum elevated over the middle temporary incisores, e. the sac of the permanent cuspidatus.

Fig. 7. Part of the under jaw of a child about fifteen months old, in which the vessels and nerve soon after they entered the common foramen of the jaw together, separated, a. the entrance of the vessels and nerve, b. b. the nerve, a small branch of the artery accompanies the nerve to nourish it, c. the principal branch of the artery, d. the anterior permanent grinder, e. the
sac

fac of the middle permanent grinder, which appears very much contracted, being preserved in spirits of turpentine, f. the socket of the posterior temporary grinder which had been taken out, g. the anterior temporary grinder, it had appeared through the gum. The situation and connexion of the permanent teeth were not preserved in this preparation.

Fig. 8. One of the incisores of a young pig, the vessels of which were filled with fine injection; part of the bony shell is cut away, to show the membrane of the pulp and the vessels expanded on its surface, a. the membrane and vessels, b. their entrance into the shell.

T A B L E II.

Fig. 1. and 2. An internal view of the jaws and teeth of a child about four years old, the alveolar processes being cut away; only one side of each is perfectly represented.

Fig. 1. The upper jaw, a. a. b. b. c. c. d. d. e. e. the temporary teeth, a. a. the middle incisores, b. b. the lateral, c. c. the cuspidati, d. d. the anterior or small grinders, e. e. the posterior or large grinders, f. f. f. the *foramen incisivum*, *septum palati*, &c. g. g. h. h. i. k. l. m. the rudiments of the permanent teeth, g. g. the middle incisores enclosed in their proper membranes, which pass upwards through the small holes and are laterally connected to the membranes of the middle temporary incisores,

incisores, the internal part of their sockets is not entirely cut away, h. h. the lateral incisores, membranes and connexion, i. i. the membranes, &c. of the bicuspidates, k. the rudiment of the cuspidatus pressed out of the circle and situated very deep in the jaw ; its membrane however passes up to the temporary cuspidatus, l. the anterior grinder covered by its membrane, the gum has been removed, m. the middle grinder, n. n. the pterygoid processes, o. o. the posterior nares, p. the gum &c. of the right side not removed.

Fig.2. The under jaw, a. a. a. a. b. b. c. c. d. the temporary teeth, a. a. a. a. the incisores, b. b. the cuspidati, c. c. the anterior grinders, d. the posterior grinder of the right side ; e. e. f. f. g. g. h. h. h. h. i. i. k. l. the membranes and connexion of the permanent teeth, e. e. the membranes, &c. of the middle incisores, f. f. those of the lateral incisores, g. g. the same of the cuspidati, h. h. h. h. the membranes, &c. of the bicuspidates, i. i. those of the anterior grinders, k. the membrane, &c. of the middle grinder, m. the connecting membrane and gum passing back over the bony partition from the anterior to the middle grinder, at the posterior part of which, the vessels at l. enter to form the wisdom tooth, n. the periosteum, vessels and nerves, entering the foramen of the jaw and distributing branches to the teeth, nearly at o. the nerve and vessels divide into two branches, the principal of which pass out to the lower lip, the others pass on to the roots of the incisores, &c. p. p. p. the spongy substance of the jaw.

Fig. 3. The temporary cuspidatus of a child about eighteen months old, furrounded by its proper membrane and the membrane of the permanent cuspidatus intimately connected with it, a. the temporary tooth, b. the connexion, c. the sac of the permanent tooth, the shell which was formed in it had been removed.

Fig. 4. An under temporary incisor of the same child, which had appeared through the gum; the connecting membrane and sac of the permanent tooth are represented, the bony shell had been removed, a. the body of the temporary tooth, b. the connexion, c. the sac.

Fig. 5. A section of the under jaw of a child about four years of age, to show that the temporary and permanent incisores are at that period contained in perfectly distinct sockets, a. the body of the temporary incisor, b. its root, c. the sac and connecting membrane of the permanent incisor passing through the small hole at d. and connected to the neck of the temporary tooth, the gum is turned up at e. to show the connexion, f. the spongy substance of the jaw.

T A B L E III.

Fig. 1. The jaws of a child about seven or eight years old, to illustrate the increase of their arches, a. a. b. b. b. b. c. c. c. c. the temporary teeth of both jaws, a. a. the lateral incisores of the upper jaw, b. b. b. b.

b. b. b. b. the cuspidati, c. c. c. c. the grinders. d. d. d. d. d. d. e. e. f. f. g. g. g. g. h. h. i. the permanent teeth, d. d. d. d. d. d. the incisores which had just appeared through the gum, e. e. the lateral incisores of the upper jaw, f. f. the cuspidati, g. g. g. g. the bicuspidates, h. h. the anterior grinders nearly perfect, and at their proper height above the level of the gum, i. the middle grinder.

Fig. 2. The upper jaw of a foetus about nine months, a. a. a. a. b. b. c. c. d. d. the sockets of the temporary teeth, a. a. a. a. the sockets of the incisores, b. b. those of the cuspidati, c. c. those of the small grinders, d. d. the sockets of the large grinders, in which the membranes of the anterior permanent grinders were contained, e. e. E. E. f. f. the incipient sockets of some of the permanent teeth, e. e. the sockets of the middle incisores, E. E. those of the lateral, f. f. those of the cuspidati, g. g. the palate processes, h. h. the *ossa palati*, i. i. i. the external plate of the alveolar processes.

Fig. 3. A carious temporary grinder, and that part of the under jaw which contained the rudiment of the bicuspis, floughed off from the sound parts, occasioned by repeated gum boils, a. one of the roots and part of the body of the grinder, b. part of the jaw, c. the surface where the second root of the grinder was situated, d. the socket, e. the bicuspis, removed from the socket.

Fig. 4.

Fig. 4. A lateral temporary incisor and cuspidatus joined together, one cavity served both for the admission of vessels, &c. a. the incisor, b. the cuspidatus, c. the cavity which contained the pulp, part of the root had been absorbed so as to expose the cavity.

Fig. 5. An internal view of a middle and lateral permanent incisor, completely joined together, a. the middle one, b. the lateral, c. a protuberance of the cortex striatus at their junction, d. a diseased hole, e. the root.

Fig. 6. An external view of the same teeth, a. the body, on which no trace is left of their junction, b. the root.

Fig. 7. A permanent cuspidatus of the right side, upper jaw, with a remarkable protuberance of the cortex striatus on it, about which, a substance similar to the crusta petrosa of graminivorous animals was deposited, a. the protuberance of the cortex striatus, b. b. b. b. the crusta petrosa, c. the perfect point of the tooth.

Fig. 8. An external view of the same tooth, a. the perfect body, b. b. the crusta petrosa.

Fig 9. The right side of the under jaw of a squirrel, the internal plate of the alveolar processes being cut away, to show the great extent of the incisor, a. a. a. the bony part of the incisor extending back to the root of the coronoid process f. b. b. the cortex striatus, c. c. c. c.

c. c. c. c. the grinders, d. the cavity of the jaw for the admission of vessels, e. the condyle, g. the angle of the jaw.

Fig. 10. A permanent incisor of the under jaw, the upper part of the cortex striatus being imperfectly formed and pitted, a. the imperfect part of the body, b. a small part of the cortex striatus perfectly formed, c. the bony part much extended.

Fig. 11. The body of a middle permanent incisor of the upper jaw, to show in what manner the earthy matter of the cortex striatus is gradually deposited, and afterwards crystallized in ranges of fibres, a. the course of the fibres.

Fig. 12. The root of a carious bicuspid of the under jaw, its membrane had been much enlarged and formed into a sac, which suppurated and burst externally, a. a. the root, b. b. the sac laid open.

T A B L E IV.

Fig. 1, 2, 3, 4, 5, 6 and 7, Represent the progress of ossification, of the anterior permanent grinder of the lower jaw. Fig. 1. Five points of ossification. Fig. 2. The shells united and turned up so as to expose the cavity. Fig. 3. The cavity divided into two openings by the incipient roots a. b. the neck. Fig. 4. a. the roots more advanced. Fig. 5. Shows the pulp a. a. advancing more rapidly than the ossification, b. the membrane intended

to form the cortex striatus, not entirely wasted, this tooth had appeared through the gum. Fig. 6. The roots more advanced, with part of the body at a. pitted or indented. Fig. 7. The roots perfectly formed, in one of which the vessels entered by two openings at a. this root was formed as Eustachius mentions, the other had but one opening.

Fig. 8, 9, 10, 11, 12 and 13, Show the progress of ossification of the anterior permanent grinder of the upper jaw. Fig. 8. Five points of ossification not as yet perfectly joined. Fig. 9. The shells united and turned up. Fig. 10. The cavity divided into three openings by the incipient roots a. Fig. 11. a. The roots more advanced. Fig. 12. a. a. a. The pulp advancing more rapidly than the ossification, b. the neck to which the investing membrane firmly adheres, it loosely surrounds the body of the tooth and is at c. held out a little from the tooth by a pin. Fig. 13. The roots perfectly formed, with but one hole in the point of each for the admission of vessels.

Fig. 14, 15, 16, 17, 18 and 19. A similar series of the bicuspid. Fig. 19. A bicuspid of the upper-jaw with two roots, which is commonly the case.

Fig. 20, 21, 22, 23, 24 and 25. Different sections of the permanent teeth, to explain the structure of the cortex striatus and bony part. a. a. a. a. a. a. the internal cavities of all the teeth, which contained the pulps, vessels, &c. b. b. b. b. b. b. their bony part, the lines which

which represent their bony lamellæ become shorter and shorter towards the internal part, c. c. c. c. c. c. their cortex striatus, the fibres of which it is composed, and also its thickness are accurately represented. Fig. 21 and 22, d. d. the commencement of the roots, to demonstrate that the internal cavities a. a. decrease more rapidly after their commencement.

Fig. 26, 27, 28 and 29, different temporary teeth, to show the wasting of their roots by absorption, a. a. a. a. the parts wasted.

Fig. 30. A permanent grinder of the under jaw, the cortex striatus of which was imperfectly formed, and remarkably pitted, a. a. four very deep pits.

Fig. 31. A grinder of the under jaw, the pulp of which did not separate into processes, so that only one root was formed, a. the cavity which contained the pulp.

Fig. 32, 33, 34 and 35, Different sections of jaws, to show the manner in which the permanent teeth appear, partly in their own sockets and partly in the sockets of the temporary teeth, and also how by the resistance of the roots of the temporary, the permanent teeth appear irregularly.

Fig. 32. a. The spongy part of the jaw, b. a permanent incisor passing into the socket of the temporary, c. the socket of the temporary tooth which had been

shed, e. the hole by which the membranes were connected, d. the socket of the lateral temporary incisor.

Fig. 33. a. The spongy part of the jaw, b. the permanent incisor appearing more internally than the hole c. through which the membranes were connected, d. the socket of the lateral temporary incisor, e. the middle temporary incisor, its root was not wasted.

Fig. 34. a. The spongy part of the jaw, b. the permanent incisor, which appeared at the internal part of the mouth on account of the resistance of the temporary cuspidatus d. c. part of the socket of the lateral temporary incisor.

Fig. 35. a. The spongy substance of the jaw, b. the bicuspid passing partly into the socket of the temporary grinder which was taken out to show the bony partition c. not yet absorbed, d. the socket of one of the roots of the grinder.

T A B L E V.

Fig. 1. Represents the right side of the lower jaw of a foetus calf about three months old, the internal plate of the alveolar processes being cut away, a. a. a. a. the membranes, &c. of the incisores, b. b. the membranes of the two anterior small grinders, c. the membrane of the first great grinder, d. the same of the second beginning to form, e. e. e. e. e. e. the connexion of the membranes, gum, vessels, &c.

Fig. 2.

Fig. 2. The pulp and bony shells of the first great grinder of the same calf, the membranes being removed, ossification commenced on six different points of the pulp, in this view three only of the shells can be seen, a. the pulp, b. b. b. the shells, c. the vessels, &c.

Fig. 3. One of the shells removed, a. the external part, b. the cavity, in which the pulp was contained.

Fig. 4. A grinder more perfect, which commenced by four points of ossification, the shells were joined, a. a. the body of the tooth, b. b. the two internal cavities into which duplicatures of the investing membrane passed, to form the cortex striatus, c. an additional process.

Fig. 5. A grinder formed of six shells, the grinding surface turned downwards, to show the junction of the internal plates of the shells and the manner in which the membranes are separated from the pulp, a. a. the junction of four of the shells perfect, b. the junction of the other two not as yet perfect, a cavity is seen, where the membrane and pulp were still in contact, c. c. protuberances occasioned by the additional processes, d. the body of the tooth.

Fig. 6. The great grinder of a foetus calf about four months, surrounded by its membranes, a. a. the external and vascular lamella turned upwards, b. b. the internal lamella, in which I could not discover blood vessels, part of it is turned up with the former to show one
of

of the bony shells c. The vessels, &c. are represented at d.

Fig. 7. A transverse section of a temporary grinder nearly perfect, a. a. a. the investing membrane passing over and down between the shells to form the internal plates of the cortex striatus, the fibres of which are seen in contact with the membrane, the pulp b. b. in contact with the bony part, which is represented white, at c. the sides of the shells approach so close together that the cortex striatus appears penniform, d. the commencement of the roots.

Fig. 8. A grinder which had partly appeared through the gum, a. a. the points which had appeared, b. b. the gum turned upwards, a few fibres of which, not being as yet wasted are shown passing down between the shells, to nourish the membrane in the hollows, c. c. the lower part of the membrane, it appears very thin on the roots, and vessels are shown passing upwards from the roots to nourish the membrane.

Fig. 9. A grinder which had entirely appeared through the gum, a. a. a. the membrane and part of the gum in the hollows dead, the nourishment being cut off by the appearance of the tooth.

Fig. 10. The upper surface of a cow's grinder which commenced by four points of ossification, when perfect the bony part could not be observed, but the upper part of the cortex striatus being worn away, the bone now appears

appears between its plates : the white lines represent the cortex striatus, a. a. a. a. the bony part, b. b. b. the hollows into which the membrane passed filled with a dark brown spongy substance, c. c. the sides which were contiguous to the other teeth, d. d. the crusta petrosa, this tooth consists of four different substances.

Fig. 11. A transverse section of a similar tooth to show the four component parts, &c. the upper part and connexion of the cortex striatus being worn away, a. a. a. a. the extent, windings and arrangement of the fibres of the cortex striatus accurately represented, b. the cavity filled with the adventitious matter, c. c. c. the bony part and also the hollows where the pulp was situated, d. the junction of the external plates of the shells, e. e. the crusta petrosa.

Fig. 12. The upper surface of a horse's grinder polished to show nearly the same structure, the white lines are the cortex striatus, a. a. a. a. the bony part, b. b. the hollows filled partly by the crusta petrosa and partly with the adventitious matter, c. c. the sides which were contiguous to the other teeth, at one side the cortex striatus is very thin, and at both the crusta petrosa is in a great measure wanting, d. d. d. d. the crusta petrosa.

T A B L E VI.

Fig. 1. An internal view of the teeth and part of the jaw of a skate, a. two or three of the front ranges of
teeth

teeth worn down by grinding, b. four ranges perfectly formed and passing upwards into the place of the former, c. four or five ranges imperfectly formed and covered by their proper membranes, d. part of the jaw.

Fig. 2. An internal view of one of the teeth removed, a. the body, b. the roots to which the ligaments were attached.

Fig. 3. An internal view of part of the jaw and teeth of the *Lophius piscatorius* to show the elastic cartilages to which the teeth are annexed, a. the cartilages, b. part of the jaw.

Fig. 4. One of the teeth removed, a. the bony part of the tooth which was not connected to the jaw in order to allow of free motion, b. the elastic cartilages.

Fig. 5. An internal view of part of the jaw and teeth of the common shark, a. a. two teeth of the first range perfect, b. a space where one of the teeth was torn away or naturally shed and the tooth c. from the range immediately underneath turning up to occupy its place, several of the lower ranges are observed imperfectly formed, their membranes were cut away, d. part of the membranes and jaw.

T A B L E VII.

Fig. 1. An instrument for lancing the gums of children, it ought to be flat and sharp from a. to b. the rest should be smooth and round.

Fig. 2.

Fig. 2. An instrument for taking out the decayed roots of teeth.

Fig. 3. A curved forceps for taking out the temporary teeth, c. a rugged groove to prevent the instrument slipping off the tooth.

SUPPLEMENTARY PLATES.

TABLE VIII.

A longitudinal section of an elephant's grinder to show its three component parts and the beautiful manner in which the plates of the cortex striatus wind through its internal substance, a. the proper bony part of the tooth which appears wavy, b. the hole leading into the cavity of the tooth for the admission of vessels, &c. to nourish the pulp and form the bony part, one continued line of the cortex striatus can be traced beginning at e. until its connexion is cut off as at c. by grinding, from c. to c. the portion of the grinding surface which came into use, a. is at the anterior part of the tooth, 1, 2, 3, 4, 5, &c. represent the crusta petrosa passing over and down between the shell as far as the junction of the plates of the cortex striatus d. d. d. the junction of the shells. In looking over

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the grinding surface of the tooth from 12. to 4. we can scarcely discern whether the crusta petrosa wears faster than the bony part or not, in the section likewise given by Mr. Corse after my plan, we cannot say which of the two substances wears down fastest, the ridges of the cortex striatus however are sufficiently obvious.

TABLE IX.

Fig. 1. Represents a longitudinal section of one of the upper grinders of an elephant in an incipient state about one third less than its natural size, a. a. a. a. &c, the crusta petrosa passing over and down between the processes until checked by the junction of the bony shells and plates of the cortex striatus. b. b. b. b. &c. the proper bony part of the tooth upon which the fibres of the cortex striatus are arranged, one continued winding line of which can be traced commencing at e. and terminating at f. where the alternate edges of the bony shells were not as yet joined, c. c. two shells still separate from the anterior part of the tooth, a sufficient quantity of the crusta petrosa not being deposited to fill up the interstices between them, six or eight similar shells but progressively smaller were forming, d. the junction of the edges of two shells, above which a small space is observed which had not been at this period filled by the crusta petrosa, f. g. h. i. the alternate edges of the bony shell which would have been united as ossification advanced.

Fig. 2.

Fig. 2. A front view of one of the shells very much diminished in size but accurately copied from fig. 90. of Dr. Blair's essay, his description of it is as follows,
 " One of the rudiments of the teeth of the lower jaw,
 " a. its upper part, which is hard, solid, and white, b.
 " its middle part distinguished by several ridges and
 " furrows, c. its lower part, which is hollow and con-
 " tained the blood vessels and nerve, &c."

Fig. 3. An internal view of the under jaw of a beaver, the inner plate of the jaw being cut away to expose the great incisor, a. a. a. the bony part, b. b. b. the cortex striatus, g. the hollow shell which contained the pulp, vessels, &c. c. d. e. f. the grinders, one continued line of the cortex striatus can be traced round each except at f. where an additional point was added the crusta petrosa is placed externally, h. the common *foramen* of the jaw, i. the coronoid process, k. the condyle.

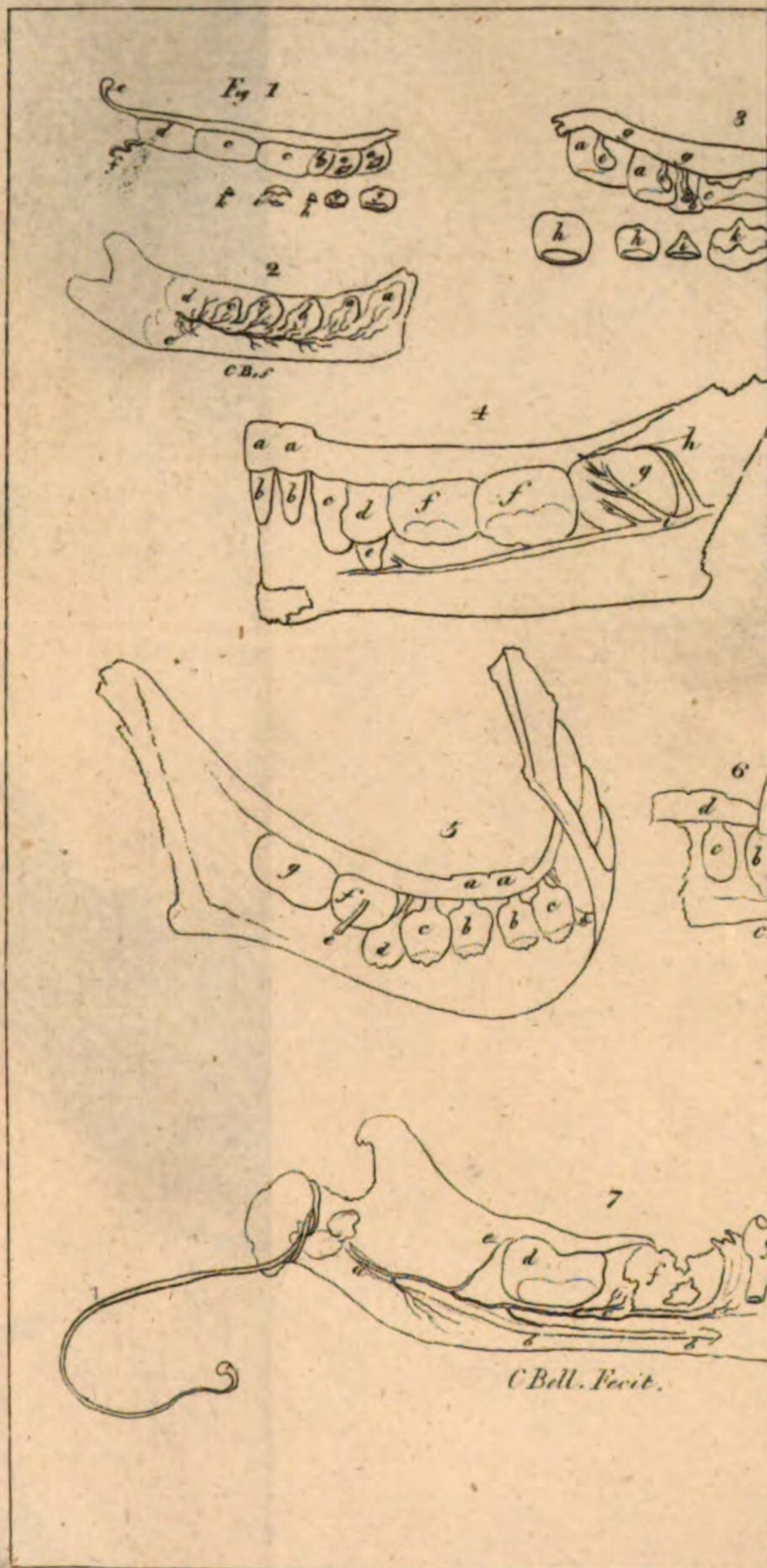
Fig. 4 One of the grinders removed, a. the grinding surface, b. the convoluted shell which contained the pulp, &c. no appearance of roots as yet forming.

Fig. 5. An under grinder of the horse previous to its having appeared through the gum, a. a. its points entirely covered by the crusta petrosa.

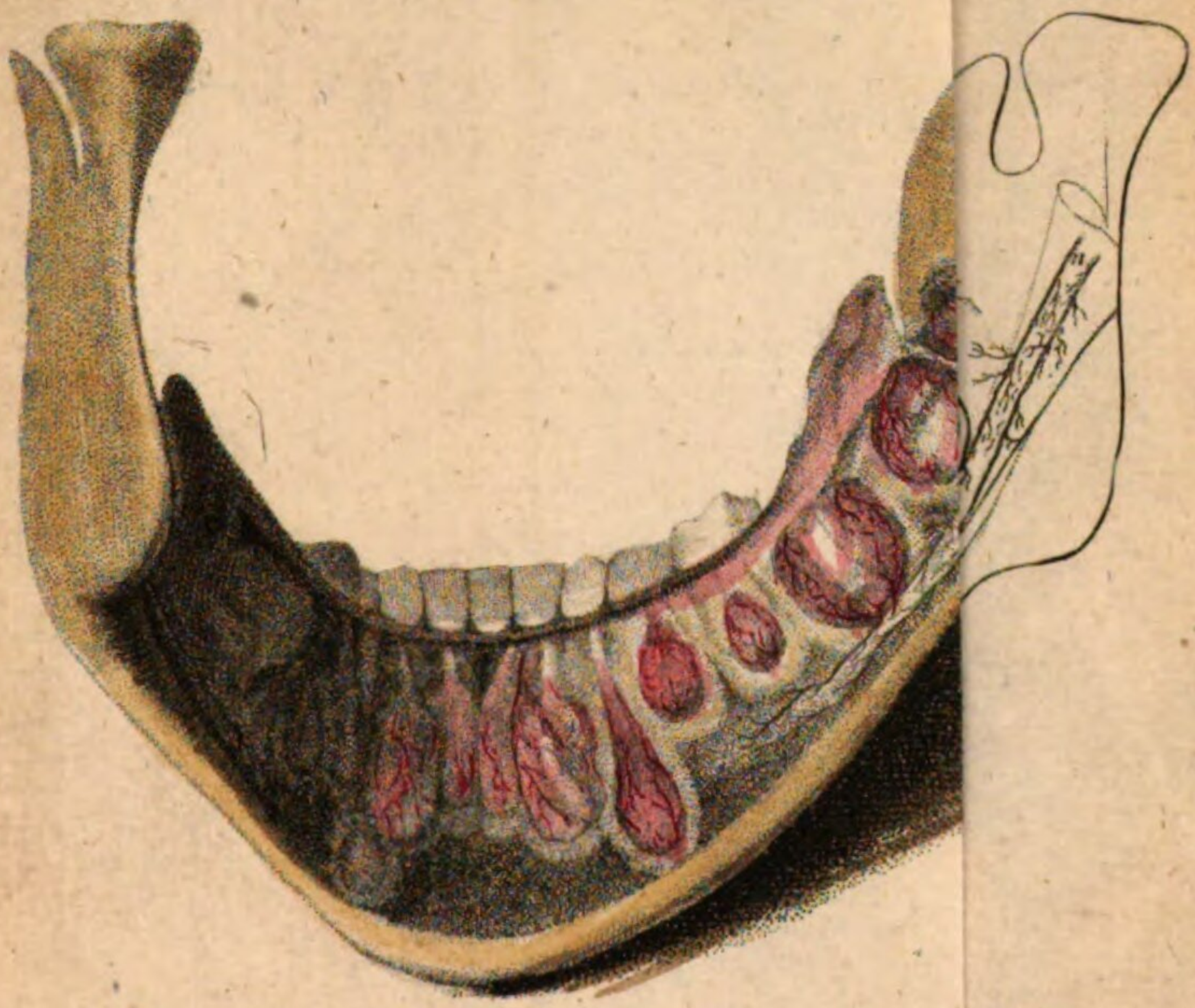
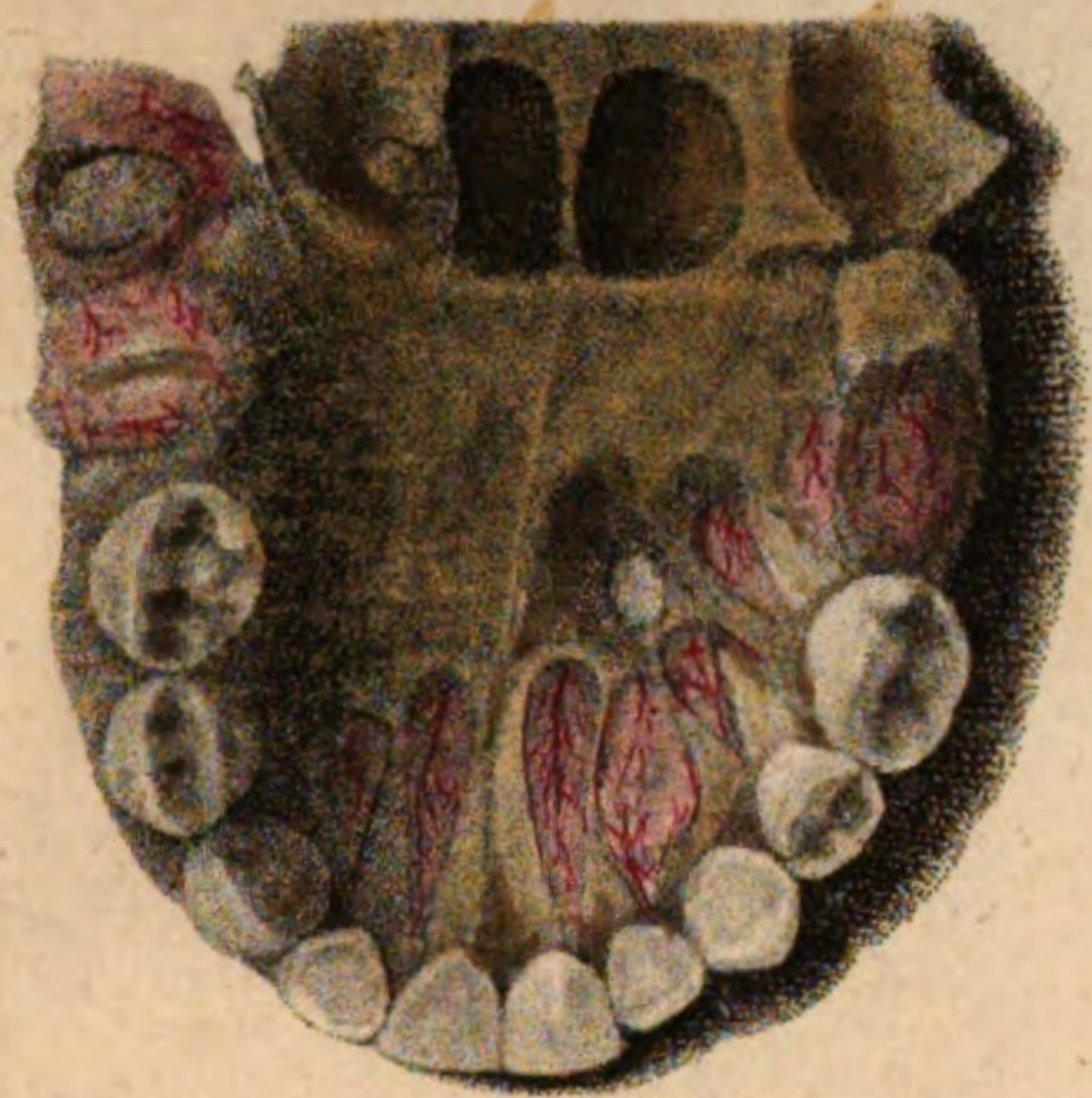
Fig. 6. An under grinder of a larger horse, which had appeared, and the points worn off by grinding,
 that

that one continued line of the cortex striatus can be traced, within which, only the bony part b. is contained, a. the crusta petrosa.

FINIS.



by R Blake,



F.3.

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Fig. 1.



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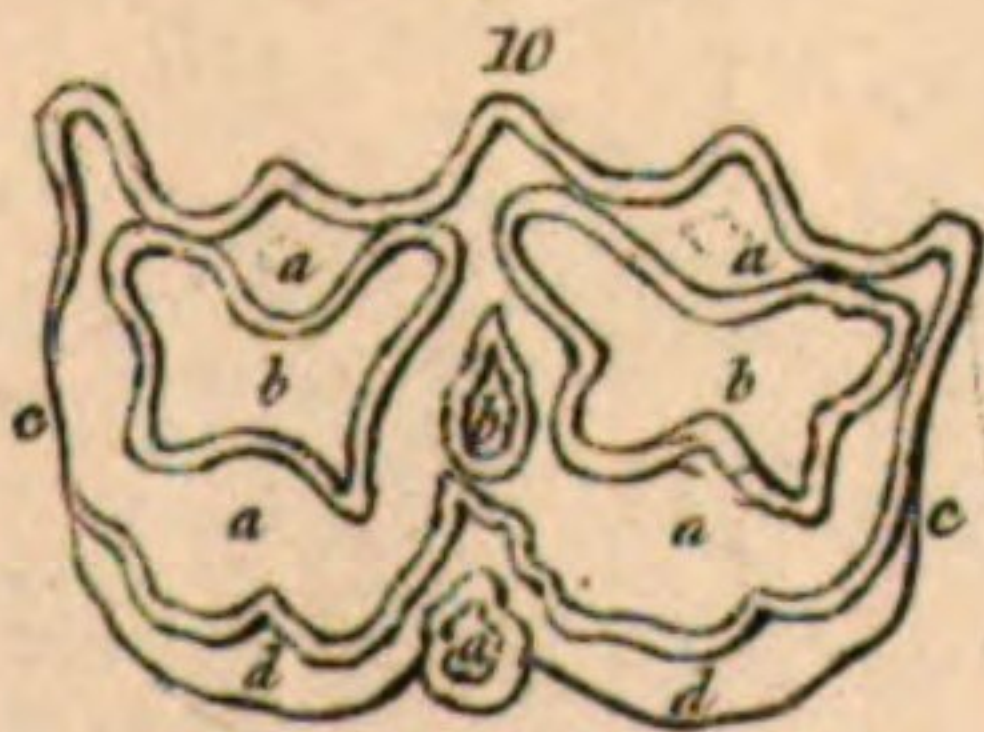
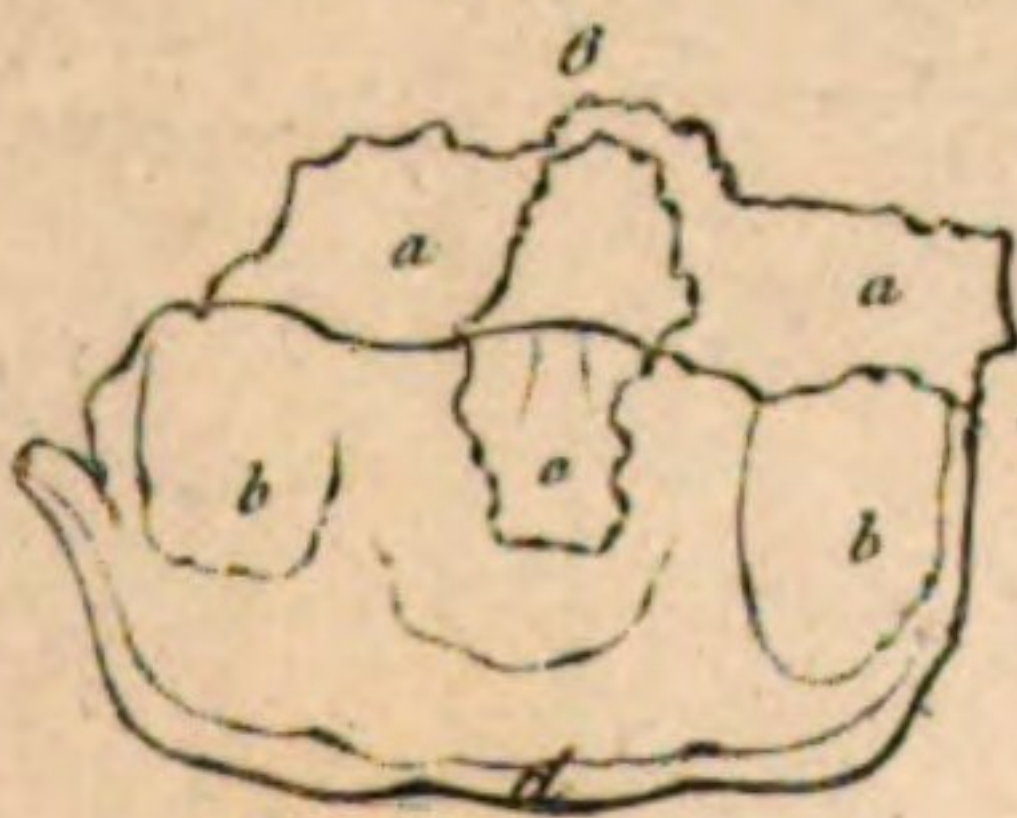
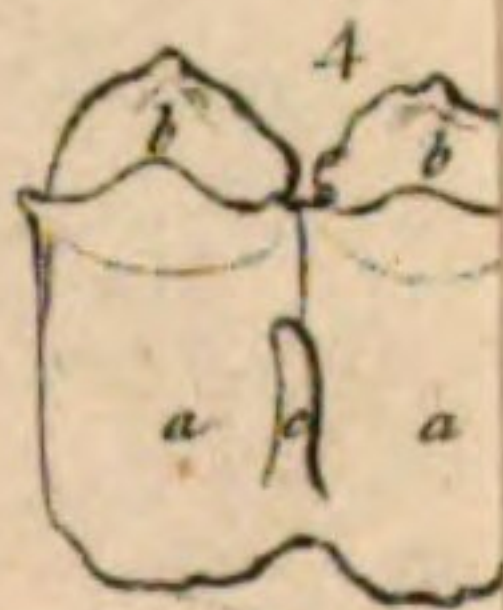
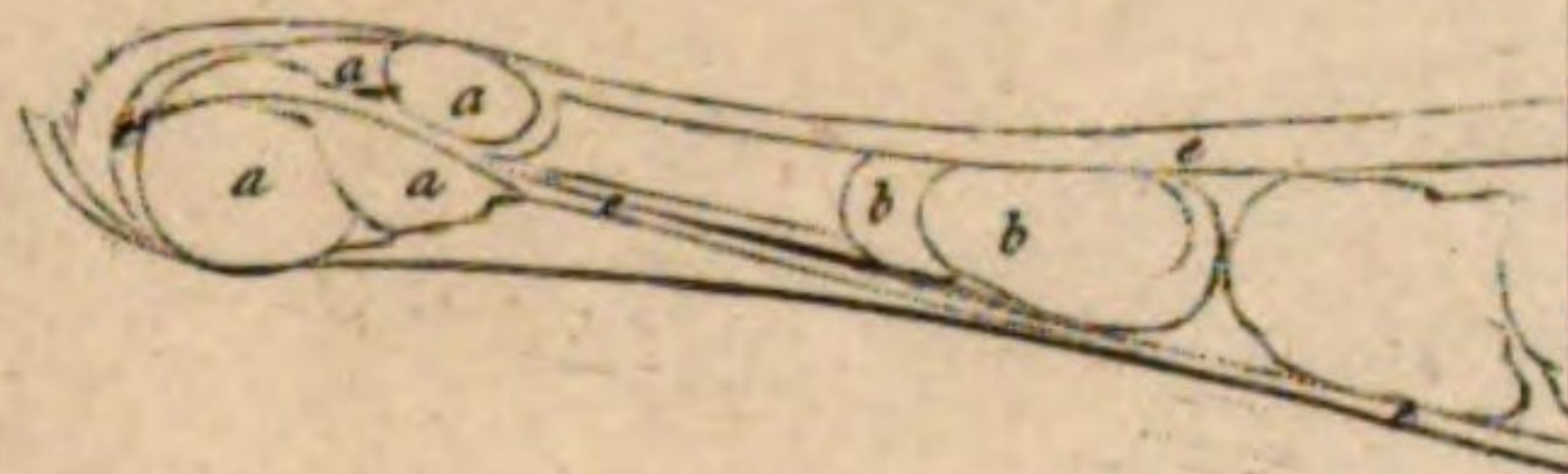
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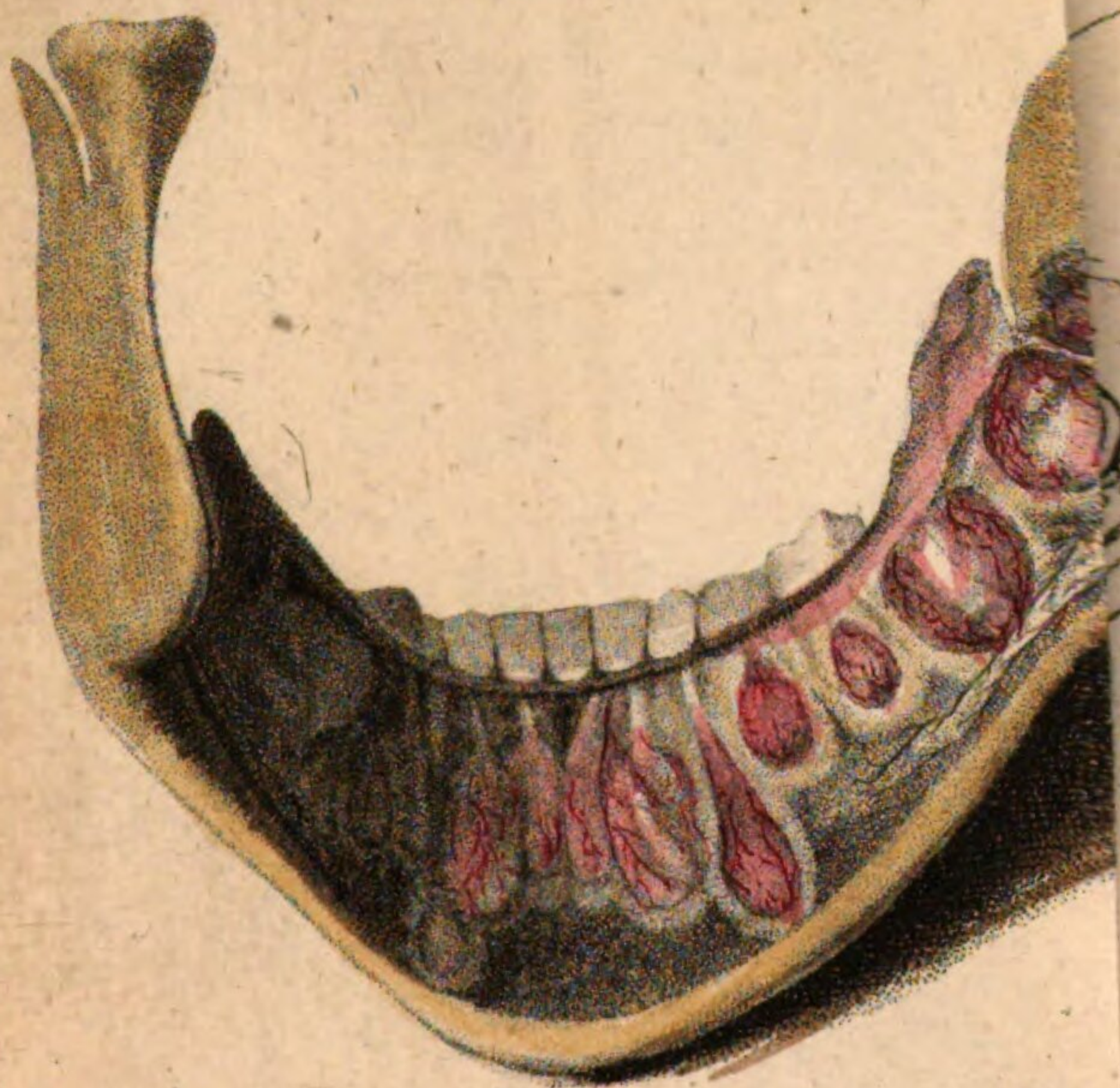
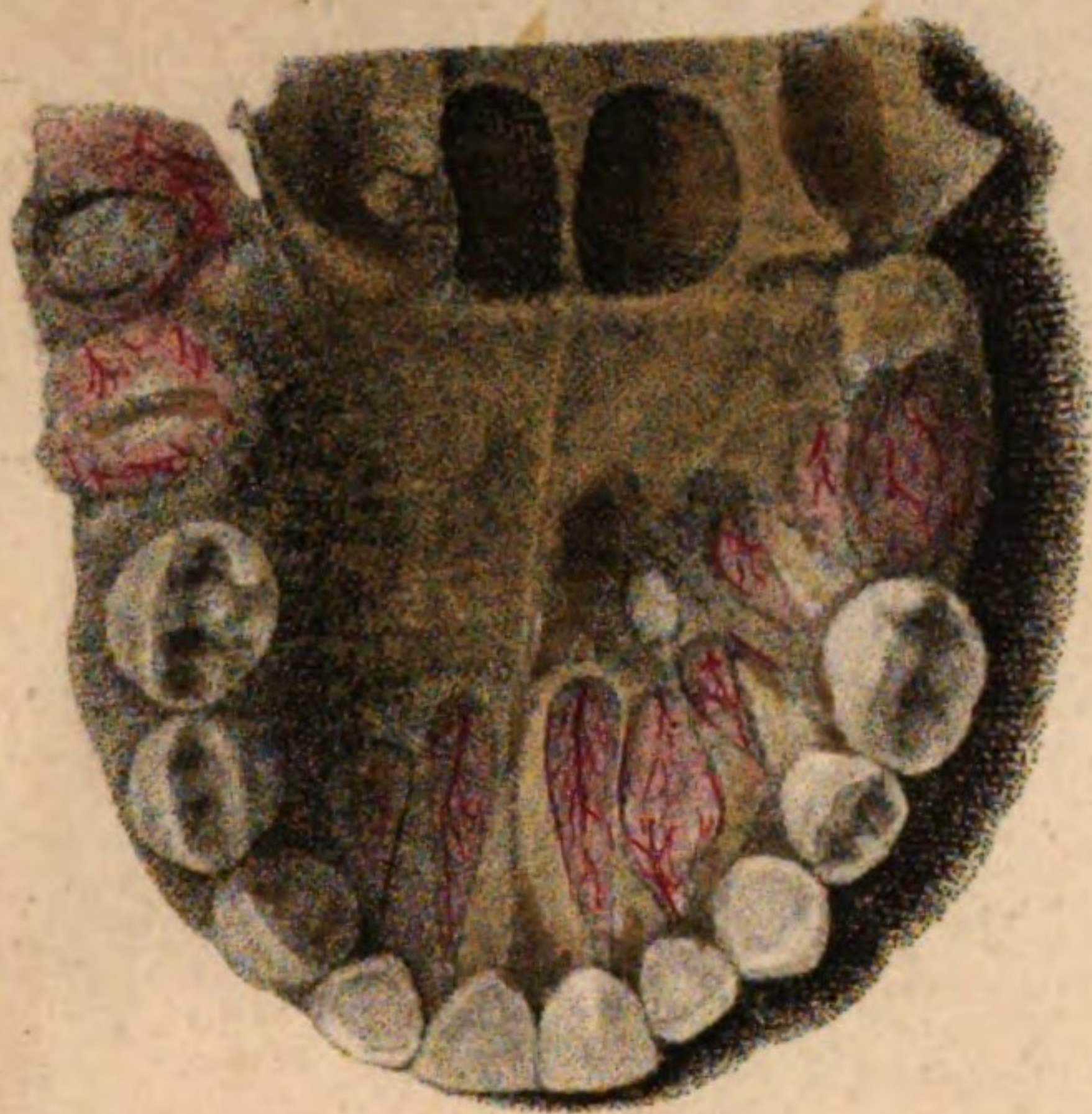
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Fig. 1.



D. Somerville Sculp.

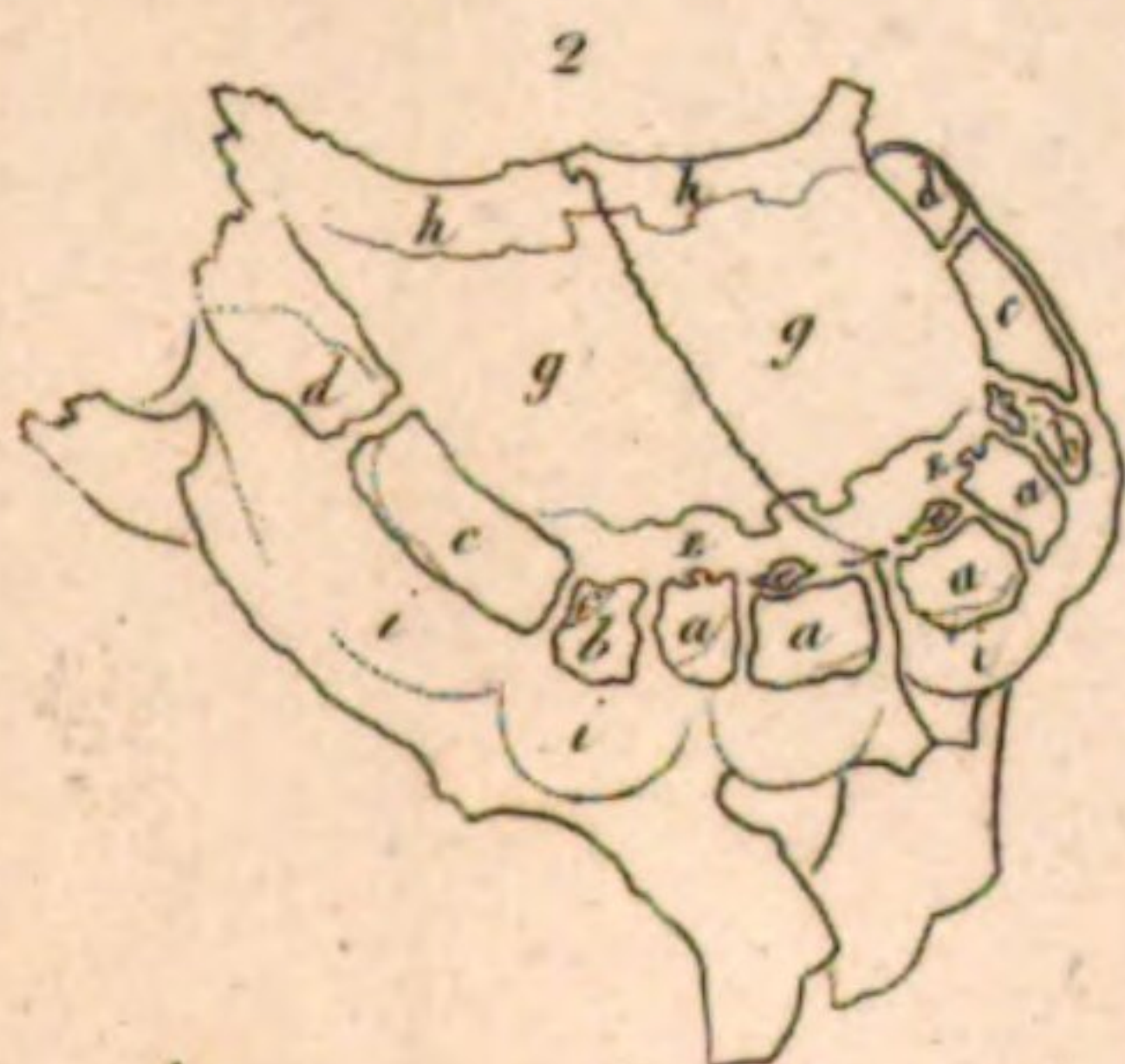
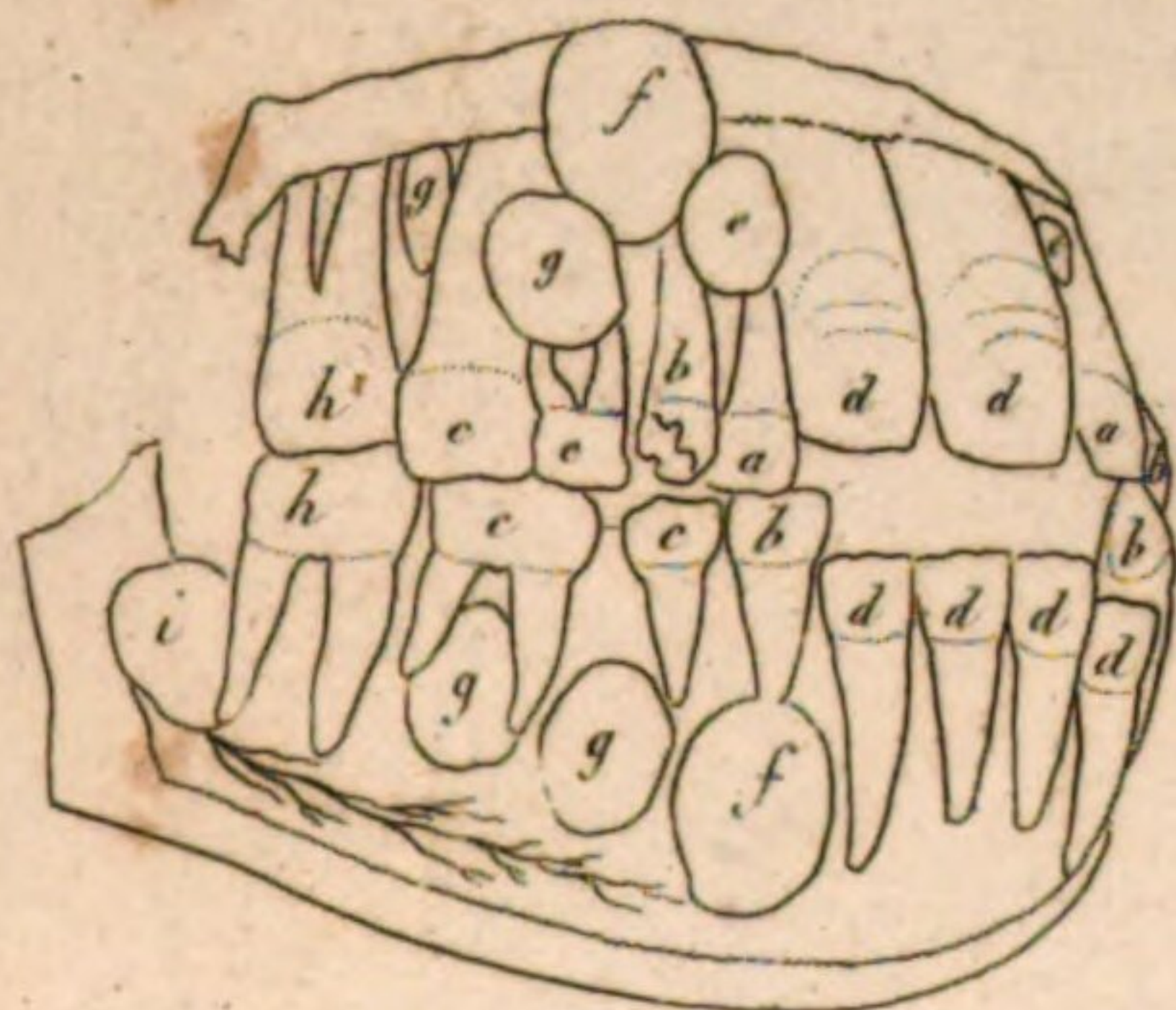




F. 3.

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Fig 1.



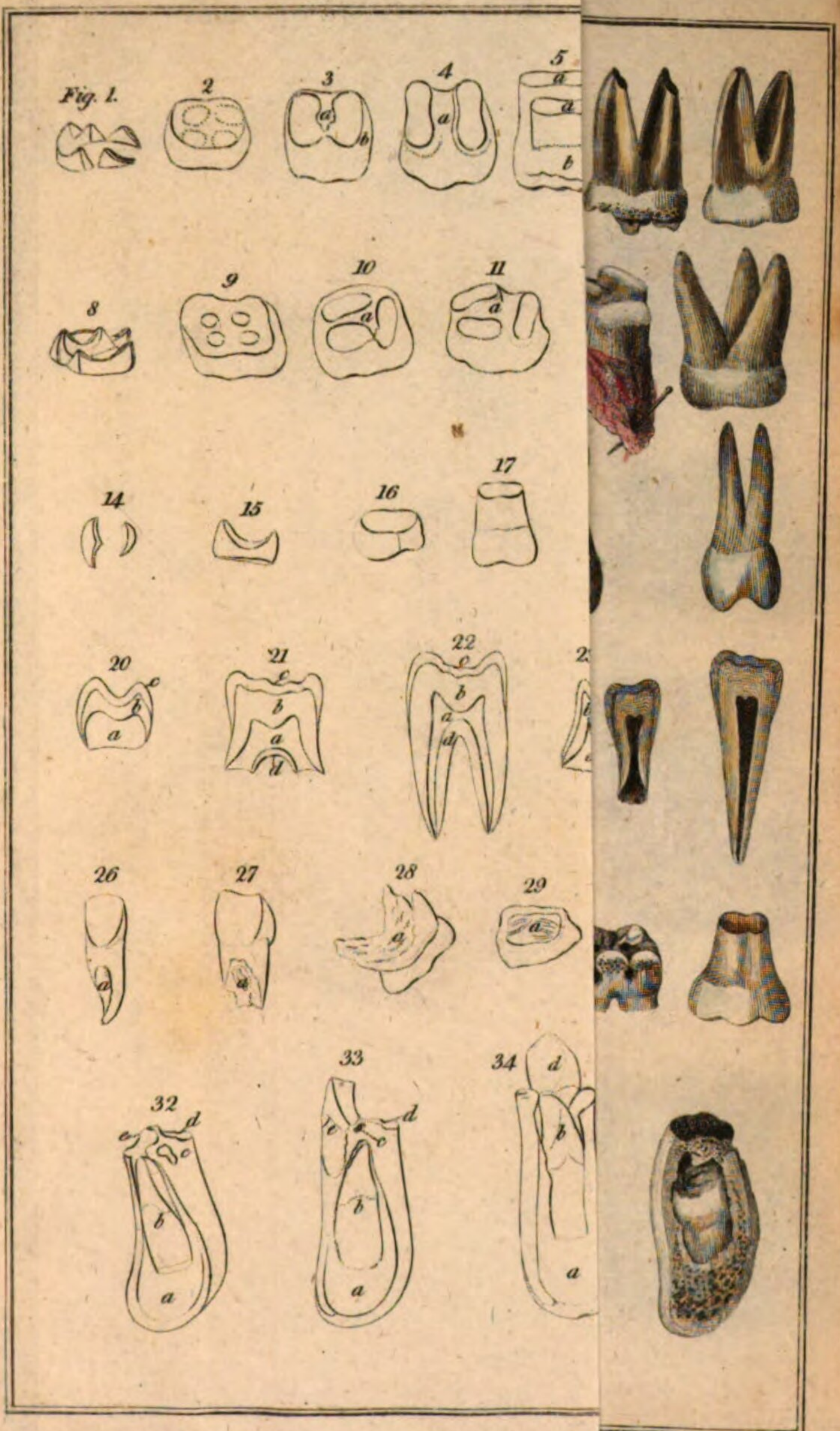
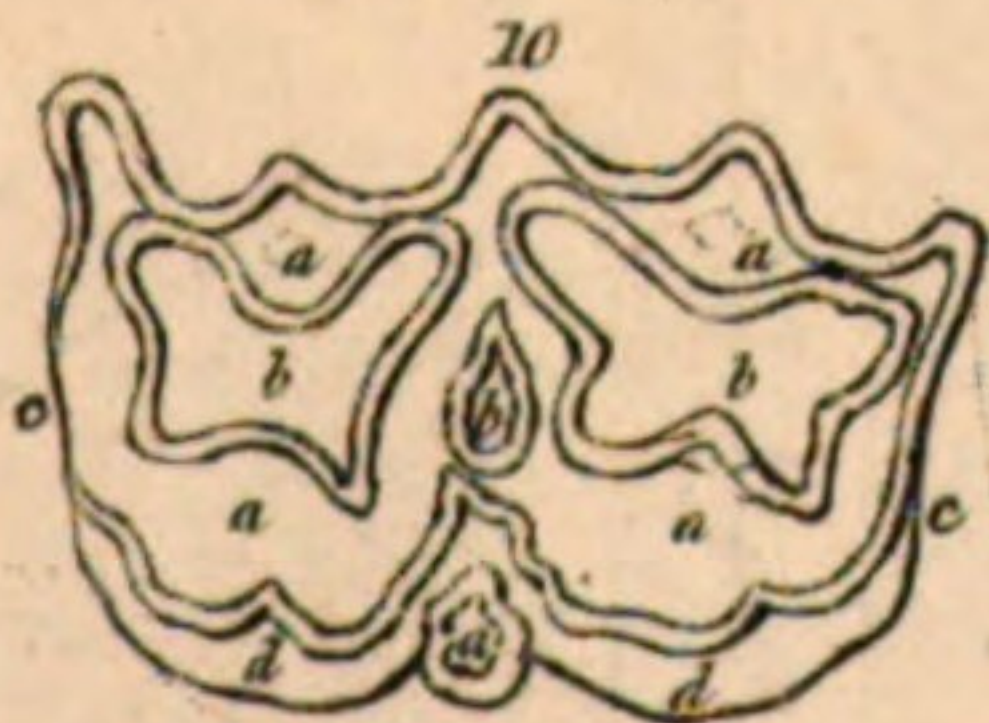
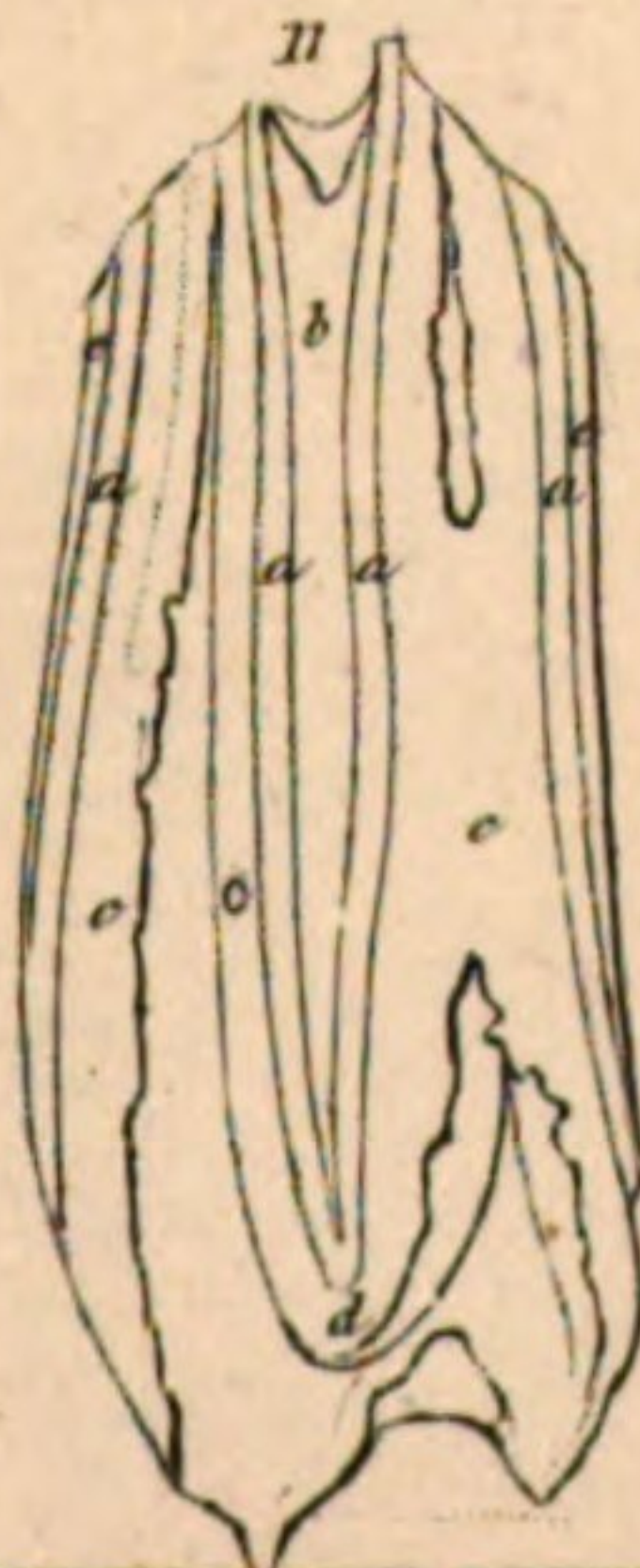
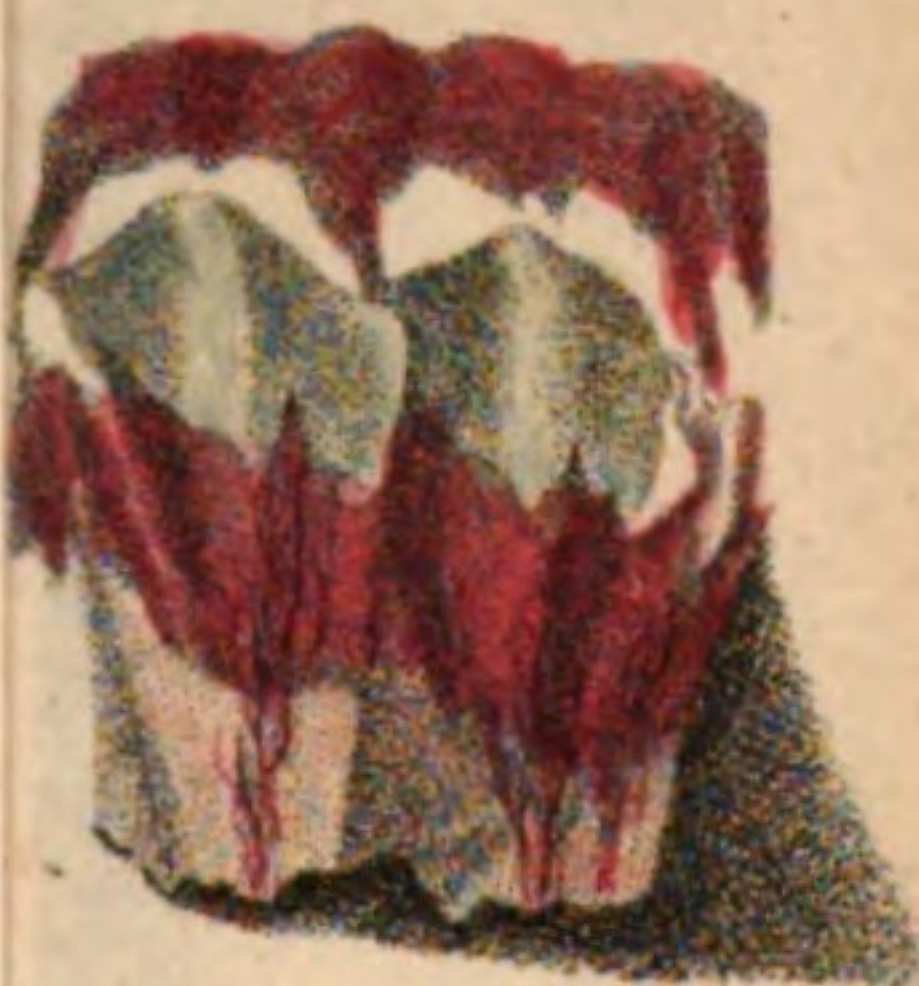
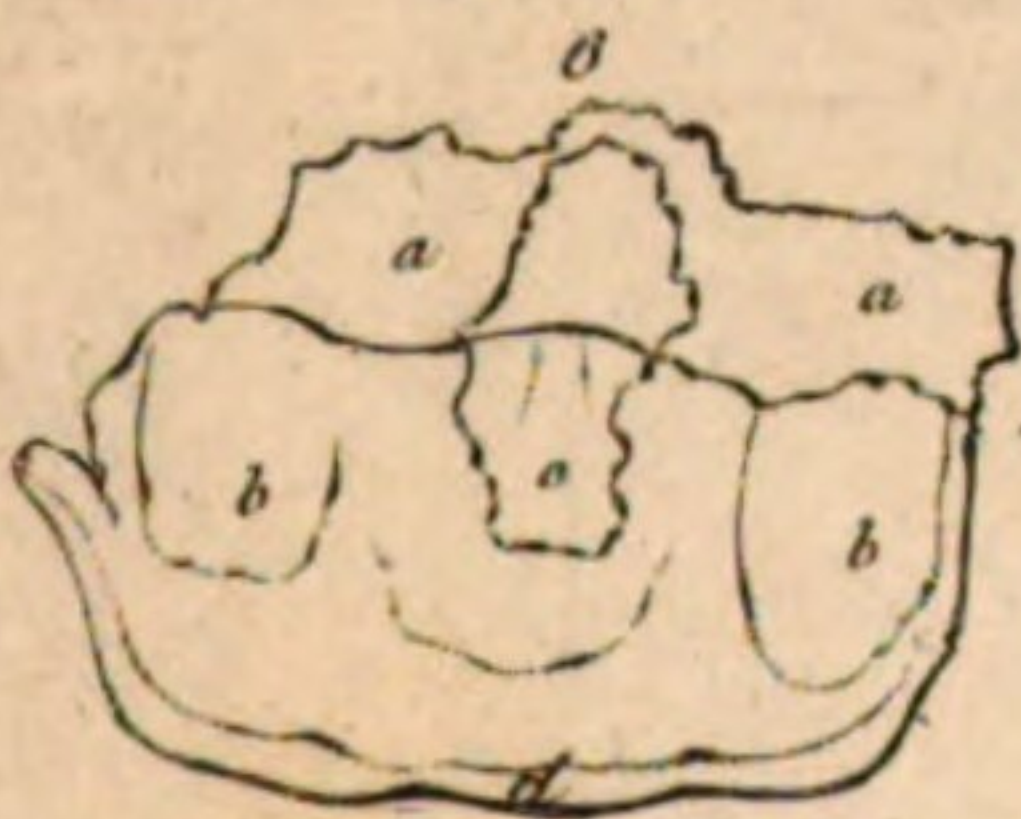
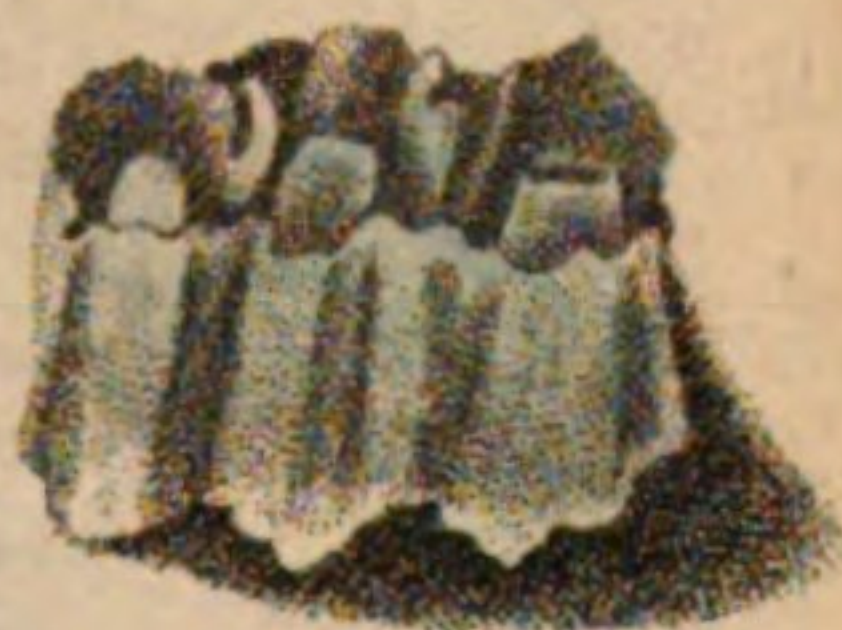
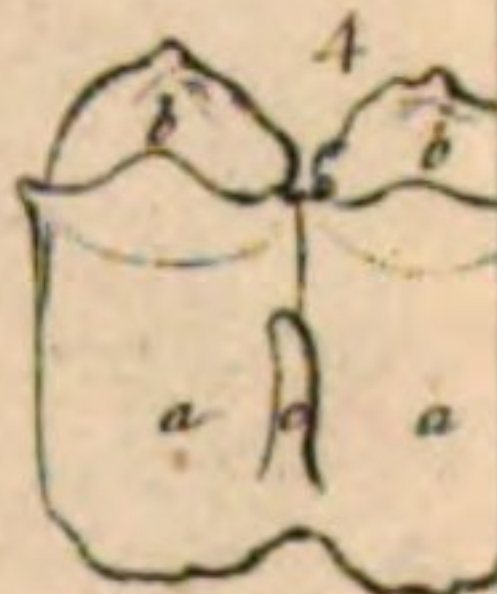
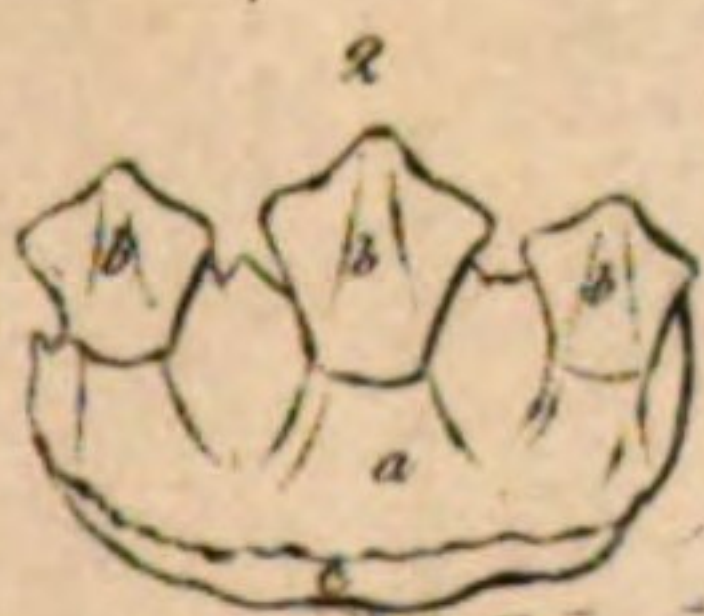
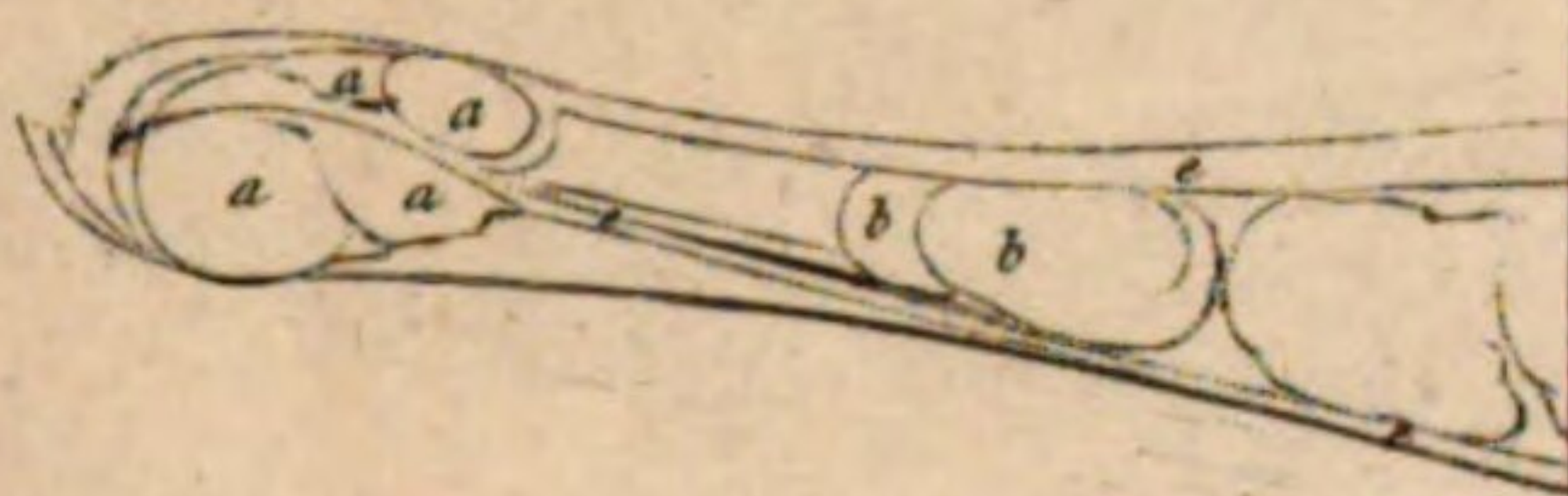


Fig. I.



D. Somerville Sculp.



Fig. 1.



Fig. 2.



Fig. 3.



R. Scott sc.

Drawn by W. H. L.

Tab as the Act directs eggs by R. Blake M.D.

Eng'd by R. A. Scott



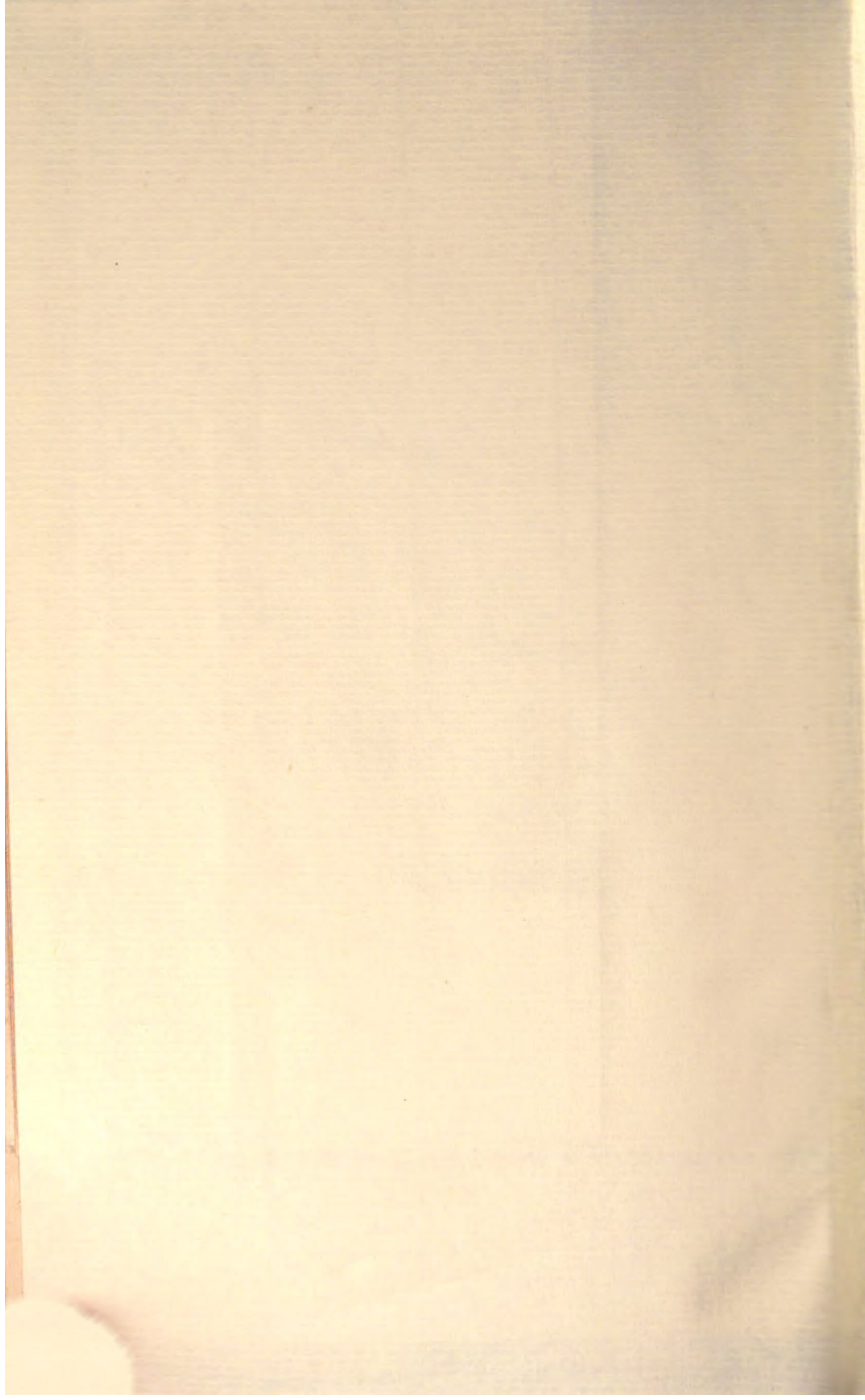
Tab VIII



Fig. 1



Sculp.



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Blake, Robert

An Essay on the Structure and Formation of the Teeth in Man and various
Animals

Dublin 1801

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